# USER'S MANUAL

# MODEL: 5971-160 Current Reversal Switch

PROPRIETARY
THIS DOCUMENT CONTAINS CONFIDENTIAL INFORMATION PROPRIETARY TO GMW ASSOCIATES. IT MUST NOT BE REPRODUCED OR DISCLOSED TO OTHERS OR USED IN ANY WAY EXCECPT FOR THE INSTALLATION, OPERATION OR MAINTENANCE OF GMW ASSOCIATES PRODUCTS.

File No: 5971-160_Reversal_Switch_Users_Manual_Rev_B Revision Date: 20 October, 2015

GMW
*955 Industrial Road, San Carlos, CA 94070 Tel: (650)802-8292 Fax: (650) 802-8298*
*E-mail: sales@gmw.com Web: http://www.gmw.com*

## TABLE OF CONTENTS


**1 WARNINGS [ Refer to this section before operation ]** **Section 1**
2.1 - Personal Safety
2.2 - Cable Connections
2.3 - Interlock Connections

**2 SPECIFICATIONS** **Section 2**
Model 5971-160 General Specifications

**3 INSTALLATION** **Section 3**
3.1 - Unpacking Instructions
3.2 - Rack Mounting
3.3 - Electrical Connections

**4 OPERATION** **Section 4**
4.1 - System Description
4.1.1 - Front Panel
4.1.2 - Rear Panel
4.2 - Initial Operation
4.3 - External Control
4.4 - Computer Control
4.4.1 - USB 6251 DAQ

**5 SOFTWARE** **Section 5**

**6 MAINTENANCE** **Section 6**

**7 DRAWINGS** **Section 7**

| | |
|---|---|
| 5971-160 Reversal Switch in a Bench Height Rack | 11907-0154-0, Rev. A |
| General Assembly | 11907-0153-0, Rev. C |
| 5971-160 Reversal Switch Block Diagram | 13907-0008-0, Rev. A |
| System Connection Diagram | 13907-0009-0, Rev. A |
| System Connection Diagram | 13907-0009-1, Rev. A |
| Internal Configuration Jumpers | 1X907-0000-0, Rev. A |
| SGA60-83 to 5971-160 Reversal Switch Cable | 16907-0062-1, Rev. A |
| 5971-160 Reversal Switch to 3473-70 | 16907-0052-3, Rev. A |
| SGA100-150 to 5971-160 Reversal Switch Cable | 16907-0062-2, Rev. A |
| 5971-160 Reversal Switch to 3474-140 | 16907-0053-3, Rev. A |
| Senis YM12 Signal & Power Cable | 16912-0000-0, Rev. A |

**8 PHOTOGRAPHS** **Section 8**
5971-160 Reversal Switch

**9 5971-160 Reversal Switch with GMW Electromagnets** **Section 9**
8.1 - Table - GMW Electromagnets and appropriate DC Power Supplies
8.2 - Performance Data; Switch voltage vs. time

**10 Warranty**

## Section 1

## WARNINGS

## REFER TO WARNINGS BELOW BEFORE OPERATING THE 5971-160 REVERSAL SWITCH

### 2.1 - Personal Safety

**Never service alone**. Do not perform service to the 5971-160 Reversal Switch and associated DC Power Supply unless another person is present who is capable of rendering first aid.

The output from the model 5971-160 Reversal Switch and its DC Power Supply is potentially lethal. It is capable of delivering high voltages at high current. Do not remove protective covers or leave cable terminations exposed. Do not operate if terminals or cables are damaged.

### 2.2 - Current Connections

Special care should be taken to insure that the current terminations are secure and do not work loose in operation. Local heating at the terminations can cause rapid oxidation leading to a high contact resistance and high power dissipation at the terminals. If left unchecked this can cause enough local heating to damage or destroy the current connection terminals.

### 2.3 - Interlocks

The 5971-160 Reversal Switch has interlock connections between the DC Power Supply and the Electromagnet load. The interlocks must be connected for proper system functioning and protection of the equipment, facility and to protect against personal injury. Attempting to operate the system with the interlocks defeated is not recommended and will void the warranty.

## Section 2

## SPECIFICATIONS

### Table 1. Model 5971-160 Current Reversal Switch Specifications

---

**Electrical**

| | |
|---|---|
| **Power Input (From DC Supply)** | 160A maximum |
| **Recommended DC Power Supplies** | Sorensen DLM40-75E<br>Sorensen SGA 60/83 60V, 83A<br>Sorensen SGA 100/150 100V, 150A<br>Sorensen SGA 160/31 160V, 31A<br>Sorensen SGA 160/62 160V, 62A<br>Sorensen SGA 160/156 160V, 156A<br>Sorensen SGA 200/75 200V, 75A |
| **Power Input (Aux Power Supply)** | 115-220VAC, 50/60Hz, 2A |
| **Power Output** | 200V, 160A maximum |
| **Switch Voltage Drop (at 20°C)** | < 440mV at 150A |
| **Switch Resistance at 150A (at 20°C)** | < 3mΩ |

Note: While the power input module has a 'selectable' voltage range, it is not necessary to select the range for any voltage between 115 - 220VAC.

**Control Modes**

**Computer Control**

National Instruments Multifunction DAQ, Model USB-6251
Current Control Resolution: 16 bits
Current & Voltage Monitor Resolution:16 bits
Digital read back of amplifier and magnet interlock status
Magnetic field read back resolution:16 bits

**Manual Control**

Manual control of the DC current via the DC Power Supply's front panel controls
Manual control of the current polarity via the Current Reversal Switch's front panel controls

**Computer Control with external Analog Current Programming Input**

National Instruments Multifunction DAQ, Model USB-6251
Current & Voltage Monitor Resolution:16 bits
Digital read back of amplifier and magnet interlock status
Magnetic field read back resolution:16 bits
User provided 0 - 10 volt analog control

| | |
|---|---|
| **Current Control Programming Voltage**[(1)] | 0 - 10 volt analog |

Note (1): The Current output control may be via either the USB interface or the external analog input, but not both.

**Mechanical**

**5971-160 Current Reversal Switch**

| | |
|---|---|
| Form Factor | 2U rack mount fully enclosed chassis |
| Overall Dimensions | 482mm (19”) wide x 88.1mm (3.5”) high x 507mm (20”) deep |
| Weight | 15.75 kg (35lbs) |

**5971-160 Current Reversal Switch & SGA Power Supply in Optima Rack**

| | |
|---|---|
| Overall Dimensions | 560.5 (22”) wide x 1,058 (41.6”) high x 823 (32.4”) deep |
| Weight (with Sorensen SGA 60/83) | 105.75kg (235lbs) |
| Weight (with Sorensen SGA 100/150) | 115kg (250lbs) |

## Section 3

## INSTALLATION

**Caution:** In many cases, the Reversal Switch and DC Power Supply will be pre-installed by GMW into a 19" EIA equipment rack. If it is not, care should be taken during rack mounting to avoid personal injury or damage to the equipment.

### 3.1 - Unpacking Instructions and Damage Inspection

#### 3.1.1 - Systems Shipped with a GMW Supplied Rack:

1. Remove all eight of the lag bolts located at the lower edge of all the side panels of the crate top cover.
2. Gently rock the crate top cover to work it loose from the shipping crate base.
3. Use one person on each side of the shipping crate grip the side panels of the crate top cover. Lift the crate top cover high enough to clear top of the rack, walk the cover sideways to a clear area and place it upon the floor.
4. Inspect the rack and its contents to ensure that no damage has occurred during shipment. If any damage is evident report the damage in detail to the shipper for claim and simultaneously notify GMW in case an assessment of the damage must be made. If no damage is found, proceed with the unpacking and installation.
5. Cut the straps that secure the rack to the pallet base.
6. Remove the wood block at the bottom front edge of the rack.
7. Carefully slide the rack forward and off of the pallet base.
8. Unpack any other system components as per their instruction manuals.

#### 3.1.2 - Systems Shipped without a GMW Supplied Rack:

1. Open the outer shipping carton by cutting the packing tape along the joints.
2. Remove the inner shipping carton by carefully lifting it out.
3. Open the inner shipping carton by cutting the packing tape along the joints.
4. Carefully lift the reversal switch clear of the shipping carton.
5. Inspect the reversal switch for any damage.
6. Retain all packing materials for future shipping needs.

### 3.2 - Rack Mounting

When rack mounting the 5971-160 Reversal Switch it is important to note that the vertical mounting flanges alone are not strong enough to support the weight of the Reversal Switch. Support angles on each side, beneath the 5971-160, must also be used. Failure to use adequate support angles will result in equipment damage.

Take care when selecting a rack that it has enough depth to completely house the Reversal Switch and DC Supply. The RC-351930 Bench Height Rack offered by GMW has an internal depth of 762mm (30"). Typical installations would put the DC Supply at the bottom of the rack, with the Reversal Switch just above, thus keeping the center of gravity as low as possible in the rack. Other instrumentation may then be installed in to the upper sections of the rack.

**Note:** Telco style racks are NOT appropriate for the Reversal Switch and DC Supply.

### 3.3 - Electrical Connections

Even if the 5971-160 Reversal Switch was ordered as a complete system and assembled into a rack by GMW, it is still recommended to follow and verify the following section as connections may have loosened during shipment.

Refer to drawing 13907-0009-0, Rev. A for a detailed connection diagram.

#### 3.3.1 - DC Supply and Electromagnet Connections

1. Connect the DC Supply to Switch Cable to the input +, input – and ground. This cable provides the DC power, ground and interlock signals between the DC Power Supply and the Switch. Ensure that ALL connections are tight, the polarity is correct and the interlock cable is properly connected.

2. Connect the Reversal Switch to Electromagnet Cable output +, output – and ground. This cable provides the current, ground and interlock signals between the Switch and the Electromagnet. Again ensure that ALL connections are tight, the polarity is correct and the interlock cable is properly connected.

**It is critical that the DC Supply to the Reversal Switch and the Reversal Switch to Electromagnet cables are connected correctly to the Reversal Switch Rear Panel terminals. Incorrect connection may cause damage to the DC Power Supply or the Reversal Switch.**

#### 3.3.2 – Reversal Switch Power

Connect the 115Vac or 220Vac power cord to the Reversal Switch. - This provides the Reversal Switch with its required auxiliary power for the interlocks, computer interface, magnetic field sensor and cooling fans.

#### 3.3.1 - DC Supply Main Power

**This procedure should be carried out by a qualified electrician.**

1. Connect the DC Supply to the AC Mains service via an appropriate three-phase AC power disconnect / breaker panel. For a GMW supported power supply, the maximum input currents per phase are given below.

| DC Power Supply | Voltage | Phases | Current per Phase |
|---|---|---|---|
| DLM40-75E, 3kW | 180-264V | 3 | 16A |
| SGA 60/83, 5kW | 187-242V | 3 | 21A |
| SGA 100/150, 15kW | 187-242V | 3 | 62A |
| SGA 160/156, 25kW | 187-242V | 3 | 103A |

2. Ensure that the Electromagnet, Reversal Switch and DC Power Supply grounds are connected. The DC Power Supply must be connected to the local service ground.

## Section 4

## SYSTEM DESCRIPTION

### 4.1 - System Description

A complete system would typically consist of an appropriate SGA series DC power supply, the GMW 5971-160 Reversal Switch, a Senis magnetic field transducer, an electromagnet and an appropriate computer and software or an external analog programming signal.

The DC Supply provides current to the electromagnet via the Reversal Switch, and is safety interlocked by means of a relay contact in the Reversal Switch. The Supply's output is enabled on a closed contact, providing protection should the interlock cable be disconnected. Two conditions will cause the interlock relay to open, shutting down the DC Supply's output: An internal fault detected in the Reversal Switch or a failure in the temperature or water flow interlocks on the electromagnet.

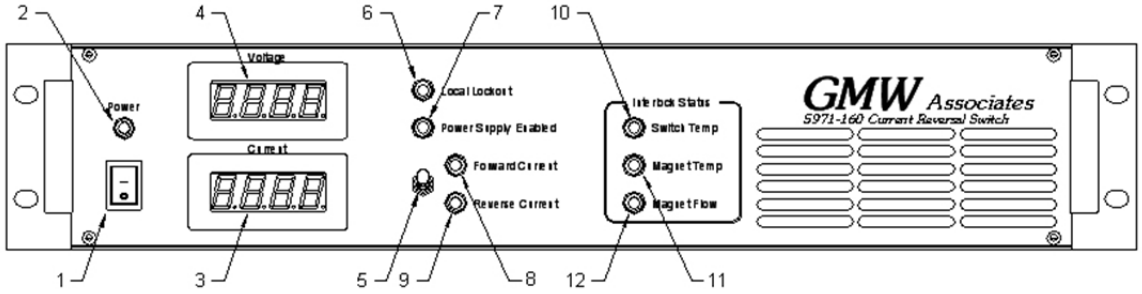
The 5971-160 Current Reversal Switch is comprised of several sections: A proprietary MOSFET switch and associated control electronics, a National Instruments USB-6251 Control with USB interface and an auxiliary power supply all integrated into a single 19" rack mounting chassis. Refer to drawing no. 13907-0008-0, Rev. A for an internal block diagram.

The auxiliary power supply provides power for the cooling fans, interlocks, control circuitry and interface. It also provides -12V and +12V (400mA each) on the rear panel for an optional external Senis Magnetic Field Transducer for magnetic field measurement and closed-loop field control.

The interlock circuit for the magnet requires a 'closed contact' connection. Provision for both the magnet over temperature and water flow is provided, and a failure of either one is indicated on the front panel of the Reversal Switch. When using the NI USB-6251 DAQ, this information is available via the computer control software. In the event of a magnet interlock fault, the output of the DC Supply is inhibited.

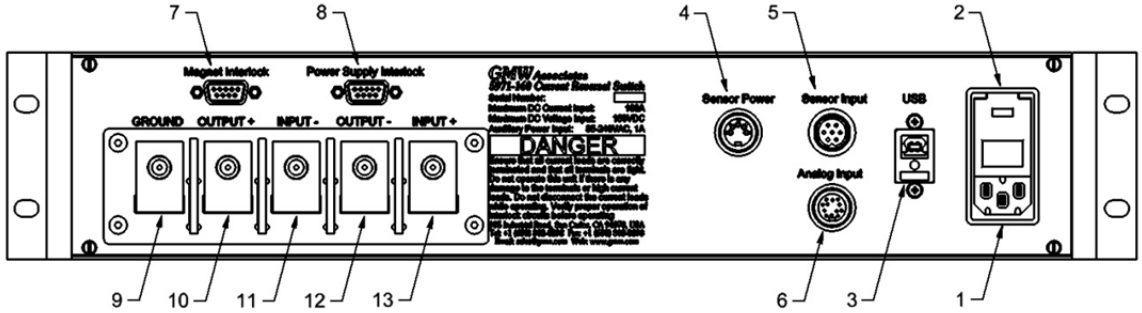
The NI USB-6251 DAQ interface provides computer control and monitoring of the system. It uses a 16-bit analog output (±10V) to provide the programming signal to the DC Supply. The output voltage and current are monitored by two 16-bit input channels. Complete Reversal switch and magnet interlock status is also monitored via its digital input channels. When using an optional Senis Magnetic Field Transducer, the field is read back on a third 16-bit analog channel. For more information, please refer to the NI USB-6251 Manual and section 4.5 in this manual.

### 4.1.1 - Front Panel




1. Power Switch
2. Power Indicator
3. Output Current Display
4. Output Voltage Display
5. Manual Current Polarity Control
6. Local Lockout Indicator
7. Power Supply Enabled Indicator
8. Forward Current Indicator
9. Reverse Current Indicator
10. Switch Over-Temperature Indicator
11. Magnet Over-Temperature Indicator
12. Magnet Water Flow Failure Indicator

### 4.1.2 - Rear Panel




1. AC Mains Input (Auxiliary Power Supply) - 115 - 220VAC, 2A
2. Fuse Holder / Voltage Selector
3. USB Port - Type B USB connection for computer control
4. Sensor Power - ± 12V power for Senis Magnetic Field Transducer
5. Sensor Input - Senis analog Magnetic Field Transducer input
6. Auxiliary Analog Inputs – Refer to section 4.4.1 USB-6521 DAQ for details
7. Magnet Interlock Connection
8. Power Supply Interlock Connection
9. Ground – Power Supply and Electromagnet GROUND connection
10. Output Positive to Magnet
11. Power Supply Negative Input
12. Output Negative to Magnet
13. Power Supply Positive Input

### 4.2 - Initial Operational Testing – Local Mode

Once the Power Supply, Reversal Switch and Electromagnet system are connected it is time to perform initial system operational checks.

Start by switching on the Reversal Switch. The power indicator should illuminate, along with the panel meters, the power supply enable and the polarity indicator as selected by the polarity control. All interlock indicators should show green.

Temporally disconnect the Magnet Interlock connector from the Reversal Switch. The 'Magnet Temp' and 'Magnet Flow' interlock indicators should illuminate red signifying a problem with the magnet interlocks. Re-connect the Magnet Interlock connector. The interlock indicators on the front panel should change to green.

Insure that the 'Voltage' and 'Current' controls on the DC Supply are turned down to their minimum values and switch on the DC Power Supply. Slowly turn up the voltage and current controls until about 5 amps is indicated on the DC Supply display. The panel meters on the Reversal Switch should show similar values for voltage and current.

> *It is important to note that for normal operation, the DC Power Supply voltage be set at Maximum. If this is not done, the DC Power Supply will be voltage limited and full output current may not be achieved.*

### 4.3 - External Control

To use the external control option, set the 'Control Mode' switch on the rear panel to 'External'. This disconnects the internal DAC and connects the DC Supply Current Input terminal to the analog input. One thing to note is that it is still possible to use the internal DAQPad for monitoring the Reversal switch even when using an external analog control signal.

Connect an analog voltage source to the Analog Input terminal. This source should be capable of delivering voltages from 0V to +10V. The power supply current output is proportional to the analog control input voltage.

### 4.4 - Computer Control

The 5971-160 is provided with a LabVIEW driver that allows basic control and monitoring of the Reversal Switch and DC Power Supply. To use the external control option, set the 'Control Mode' switch on the rear panel to 'Internal'. This connects the internal DAC to the DC Power Supply analog control input.

Start up the computer software and ensure that everything configured correctly. Please refer to section 5 of this manual for more information.

### 4.4.1 - USB-6251 DAQ

The National Instruments USB-6251 DAQ together with GMW's Magnet Control software provides control and monitoring of the 5971-160 Reversal Switch. If GMW's Magnet Control software is not used, it is still possible to computer control the 5971-160 Reversal Switch by writing custom software to communicate with the USB-6251. The table below describes the channels used and their functions.

| USB-6251 Connections | | | |
|---|---|---|---|
| **Signal** | **Type** | **Direction** | **6251 Terminal** |
| **Current Control Output**<br>10V output proportional to 100% current output | Analog Single Ended | Output | AO-0 |
| Current Control Common | Ground | Ground | AO-GND |
| **Voltage Monitor**<br>10V / 100% of the power supply's rated output voltage | Analog Single Ended | Input | AI-0 |
| Voltage Monitor Common | Analog | Input | AI-GND |
| **Current Monitor**<br>10V / 100% of the power supply's rated output current | Analog Single Ended | Input | AI-1 |
| Current Monitor Common | Analog | Input | AI-GND |
| **Field Monitor +** | Analog | Input | AI-2 |
| **Field Monitor -** | Analog | Input | AI-10 |
| Field Monitor Common | Ground | Ground | AI-GND |
| | | | |
| **- Reserved -** | Digital | Input | P0.0 |
| **Switch Temp – Low = Okay** | Digital | Input | P0.1 |
| **Magnet Flow – Low = Okay** | Digital | Input | P0.2 |
| **Magnet Temperature – Low = Okay** | Digital | Input | P0.3 |
| **P/S Enabled – High = Enabled** | Digital | Input | P0.4 |
| **Polarity Status – High = Forward** | Digital | Input | P0.5 |
| **Local Lockout – High = Remote** | Digital | Output | P0.6 |
| **Polarity Control – High = Forward** | Digital | Output | P0.7 |
| **Interlock Status Common** | Ground | - | DGND |
| **+5V Power** | Power | - | +5V |

| USB-6251 Connections - USER ACCESSABLE | | | |
|---|---|---|---|
| The analog input channels below are available on the rear panel of the 5971-160 for user connection. They may be configured as single-ended or differential. The full-scale ranges may be configured as ±2V, ±5V, or ±10V | | | |
| **Signal** | **Type** | **Direction** | **6251 Terminal** |
| **Analog Channel 3** | Analog | Input | AI-3 |
| **Analog Channel 4** | Analog | Input | AI-4 |
| **Analog Channel 5** | Analog | Input | AI-5 |
| **Analog Channel 6** | Analog | Input | AI-6 |
| **Analog Channel 7** | Analog | Input | AI-7 |
| **Analog Channel 11** | Analog | Input | AI-11 |
| **Analog Channel 12** | Analog | Input | AI-12 |
| **Analog Channel 13** | Analog | Input | AI-13 |
| **Analog Channel 14** | Analog | Input | AI-14 |
| **Analog Channel 15** | Digital | Input | AI-15 |
| **Analog Input Ground** | Ground | Ground | AI-GND |

Please refer to the National Instruments USB-6251 DAQ manual for configuring the analog channel inputs.

## Section 5

## SOFTWARE

The 5971-160 Reversal Switch is provided with basic control and monitoring software. This section covers the installation and basic operation of the software.

### 5.1 - Software Installation

Install the software packages in the order below. This should ensure that all components are correctly installed and working.

1. Install the National Instruments software and driver package, NI-DAQmx, according to the instructions in the National Instruments software manual.

2. Connect the Reversal Switch to the computer.

3. Using the National Instruments software, Measurement and Automation Explorer, verify communication between the computer and the Reversal Switch.

4. Install the GMW Reversal Switch software.
   The GMW supplied software allows basic control and monitoring. There are two options when installing the software. The first is a basic run-time version that does not allow modification of the software. The second option is a set of virtual instruments (VIs) that may be modified to suite a custom application. Note that the ability to use the VI version requires the purchase of the complete National Instruments LabVIEW software package.

#### 5.1.1 - Installing the Run Time software version

1. Insert the GMW supplied software disc in to the CD or DVD drive.

2. Run the setup.exe located in the directory \Installer\Volume.
   This will install both the runtime and source VIs and by default, the installer will place the files in the directory c:\program files\GMW 5971 Reversal Switch\. You may change this at the time of installation.

3. After the setup has completed, read the readme file for any last minute changes or notes.

### 5.2 - Operating the Reversal Switch using the GMW Software

Once the software is installed, it will be possible to control and monitor the Reversal Switch using the supplied software.

#### 5.2.1 - Running the software

1. The runtime version is accessed via the start menu:
   Start > All Programs > GMW 5971 Reversal Switch V1_0> GMW Reversal Switch 5971-160.exe

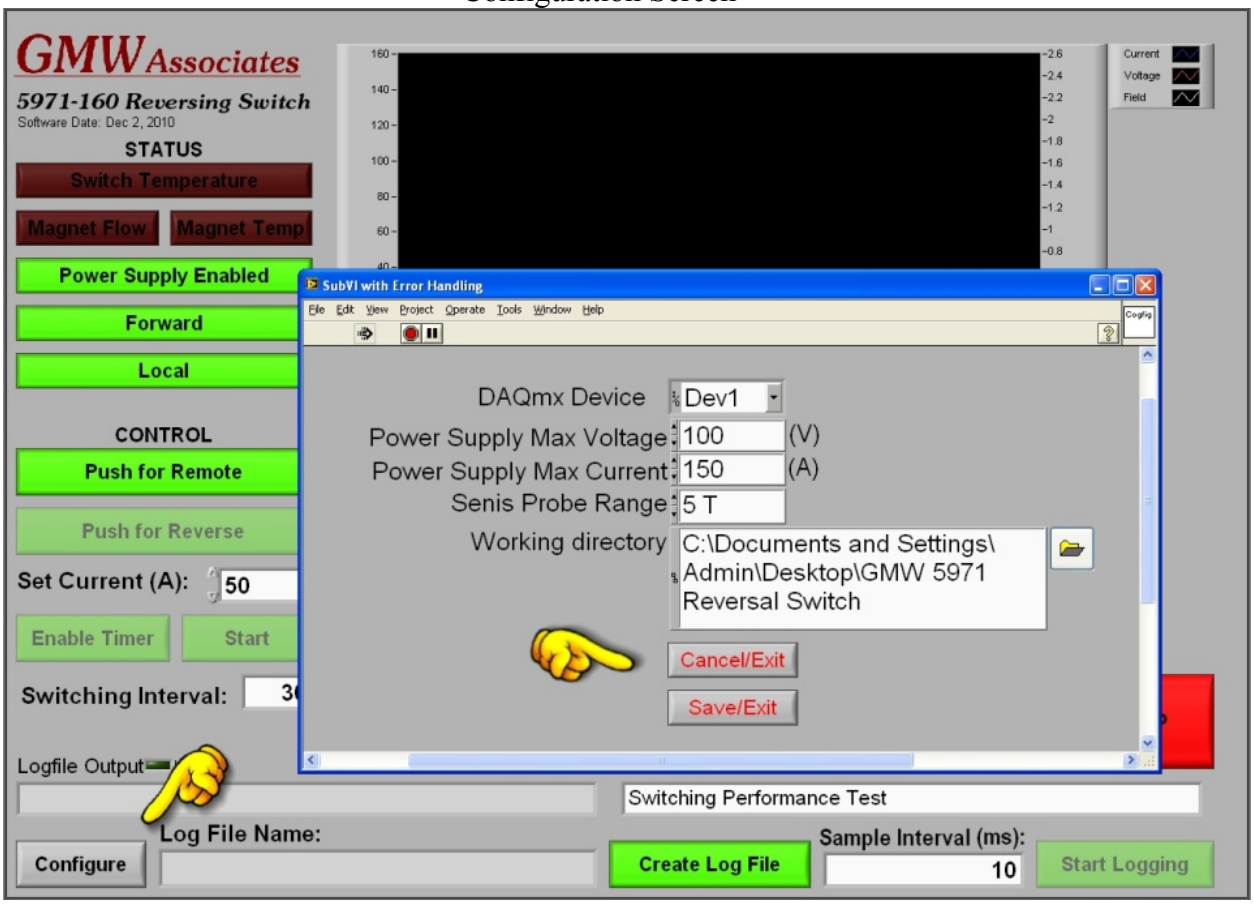
2. The source VIs are located in the directory c:\program files\GMW 5971 Reversal Switch V1_0\Source VI\. Note that LabVIEW 8.6.1 or later is required to run, view or modify the source VIs.

### 5.2.2 - Software Configuration

Upon the first run of the software, a simple configuration screen will be presented. Select the DC Power Supply type from the provided list. If the power supply that is being used is not listed, enter the maximum voltage and current of the DC Power Supply that you have. Then select the address of the USB-6251 DAQ from the list. You may also enter the default directory to be used for storing data generated from the data logger.

Save and exit the configuration screen.

Configuration Screen




### 5.2.3 - Basic Operation

Once configured, the normal operation screen will be presented. This screen provides control of current and polarity and monitoring of the DC Power Supply's output voltage and current. It also provides status read back of the Reversal Switch and Electromagnet interlock status.

*It is important to note that when operating remotely, the DC Power Supply front panel controls be set as follows: Voltage to Maximum, Current to zero. If this is not done, the DC Power Supply will be voltage limited and full output current may not be achieved.*

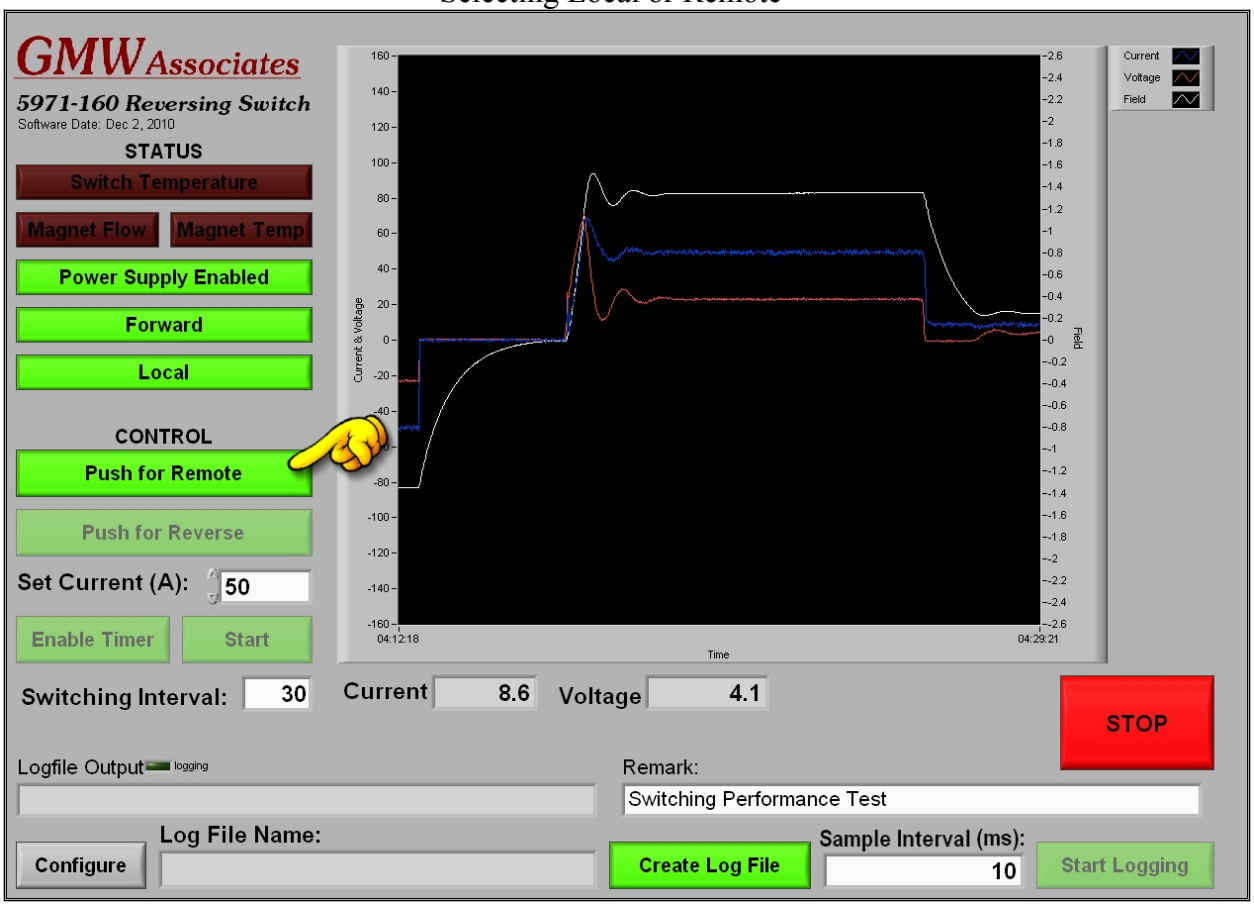
### 5.2.4 - Local / Remote

The Reversal Switch software defaults to local operation. In order to control the Reversal Switch it must first be placed into the 'Remote' mode. This is done by clicking on the Local / Remote' Control. This control will change its state depending on what mode it is in. The two states are:

'Local' - The control is green and displays the legend 'Push for Remote'

'Remote' - The control is yellow and displays the legend 'Push for Local'

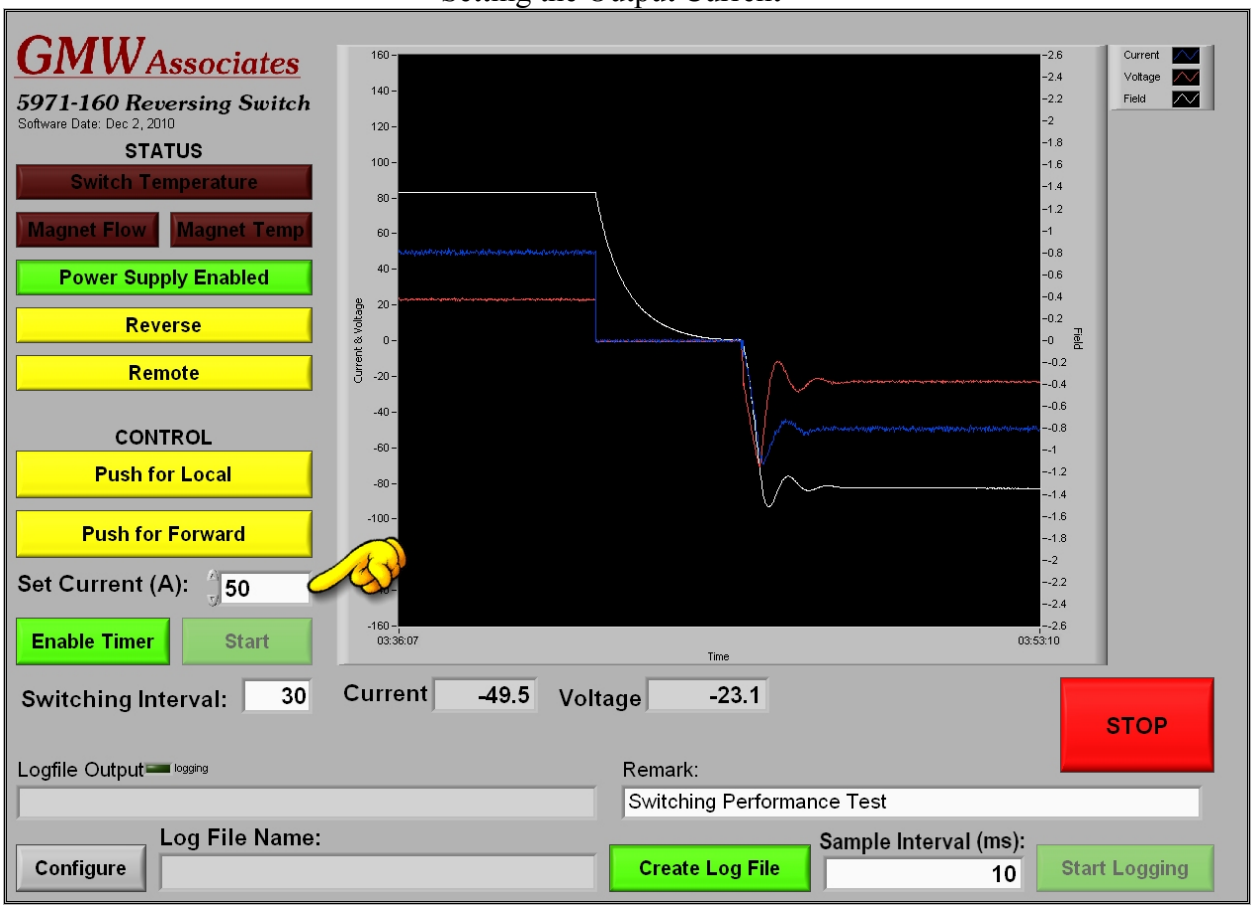
Selecting Local or Remote



### 5.2.5 - Setting the output current

The output current is simply set by entering the desired output current in the current control box.

Setting the Output Current

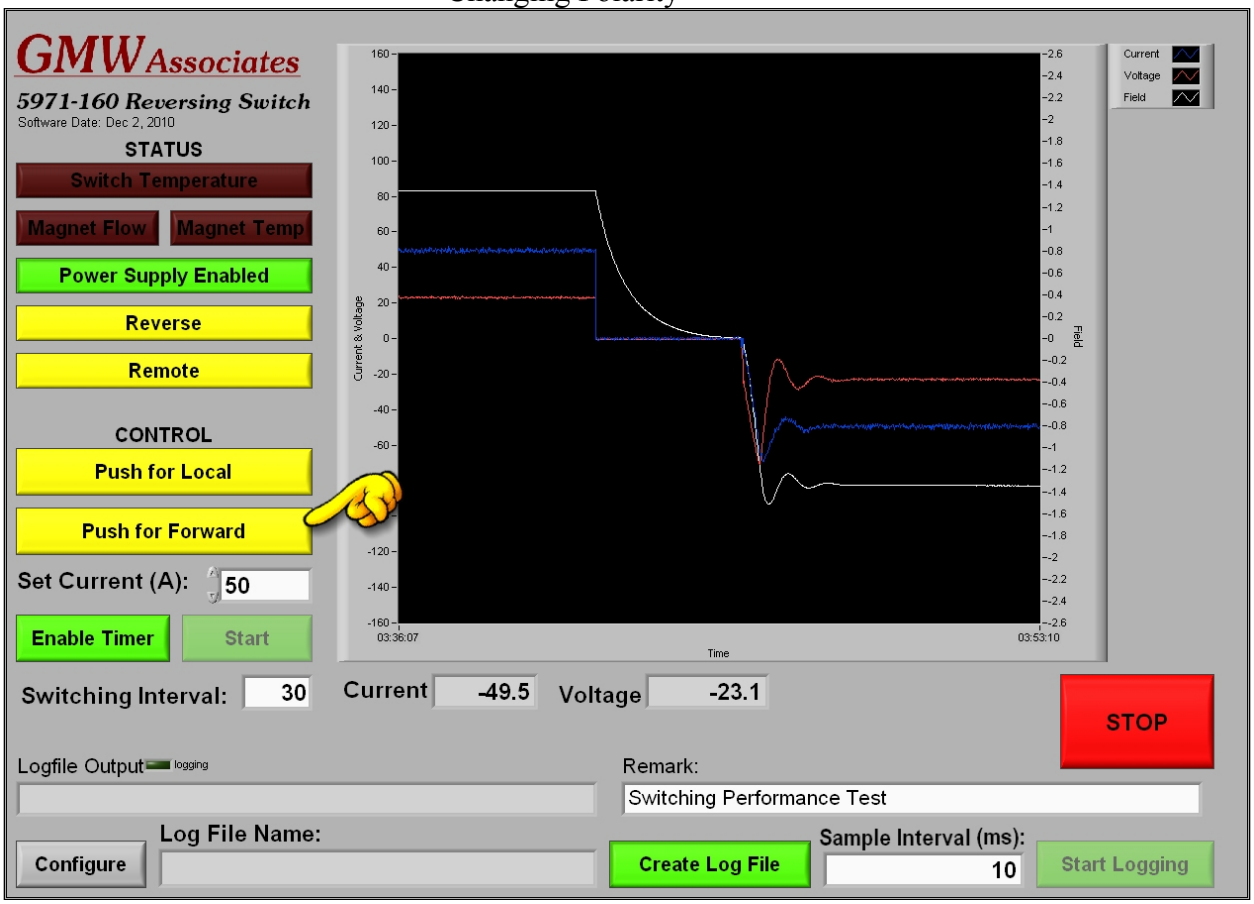


### 5.2.6 - Selecting the Reversal Switch polarity

To change the Reversal Switch polarity, simply click on the polarity control toggle. The Reversal Switch will then inhibit the DC Power Supply's output, wait for the voltage to drop to a safe level, change polarity and then re-enable the DC Power Supply's output.

*The switching time will depend on the configuration of the load. Switching times may approach 20 seconds.*

Changing Polarity



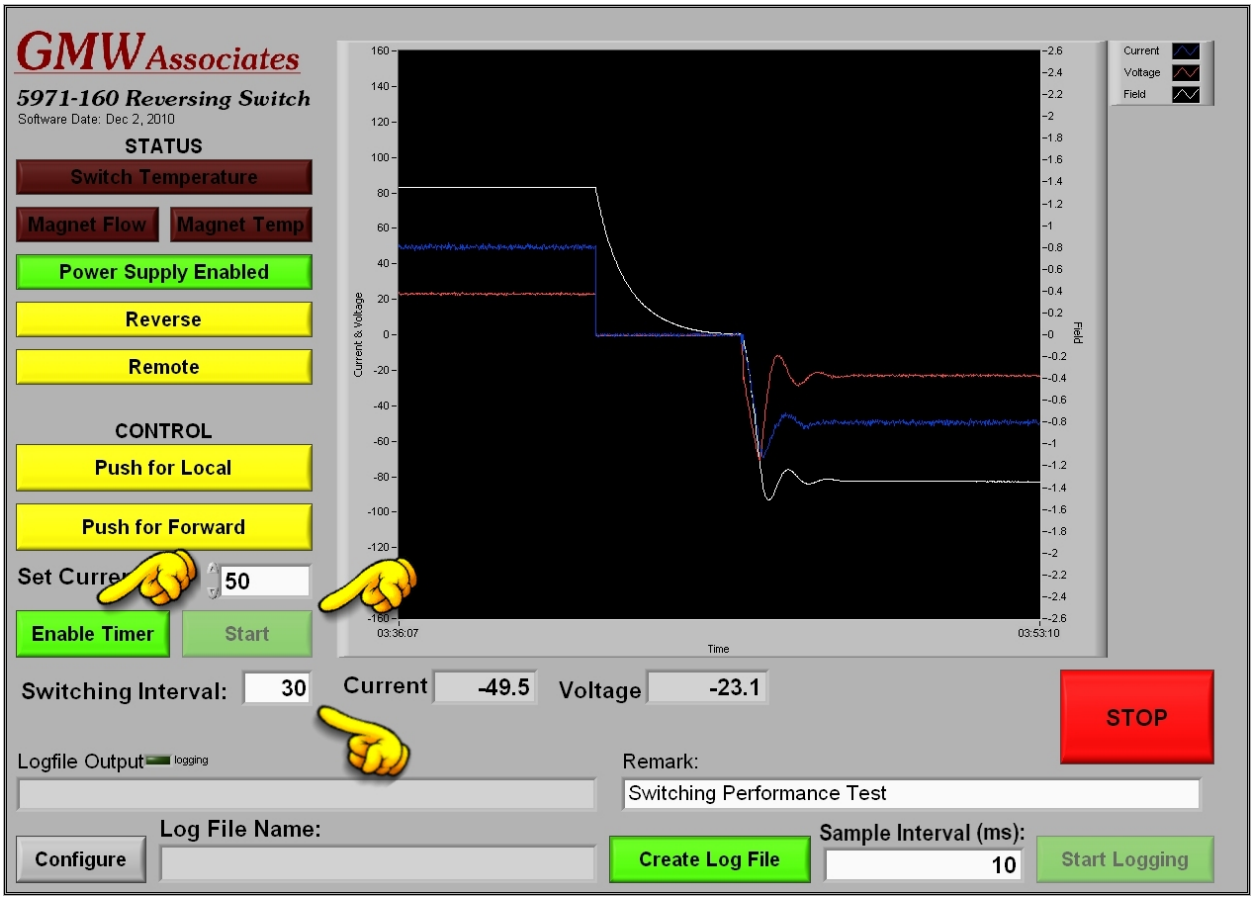
### 5.2.7 - Timed Switching

The software has the ability to automatically switch at a rate chosen by the operator. To use the timed switching function follow the procedure below.

1. Push the ‘Enable Timer’ button.

2. Enter the desired time switching interval in seconds. Note that 30 seconds is the minimum interval.

Timer Enable and Interval




3. Press the ‘Start’ button.

*Note that while timed switching is enabled, the regular forward / reverse control is disabled..*

### 5.2.8 - Data Logging

There are a few things to set up in order to use the data logger:

1. Push the 'Create Log File' button. This will open a dialog box that will prompt for the file name of the log file. If the file exists, it will prompt for confirmation to over write the existing file.

2. Enter a log file sample interval (in mili-seconds). Set to 0 to log every sample.

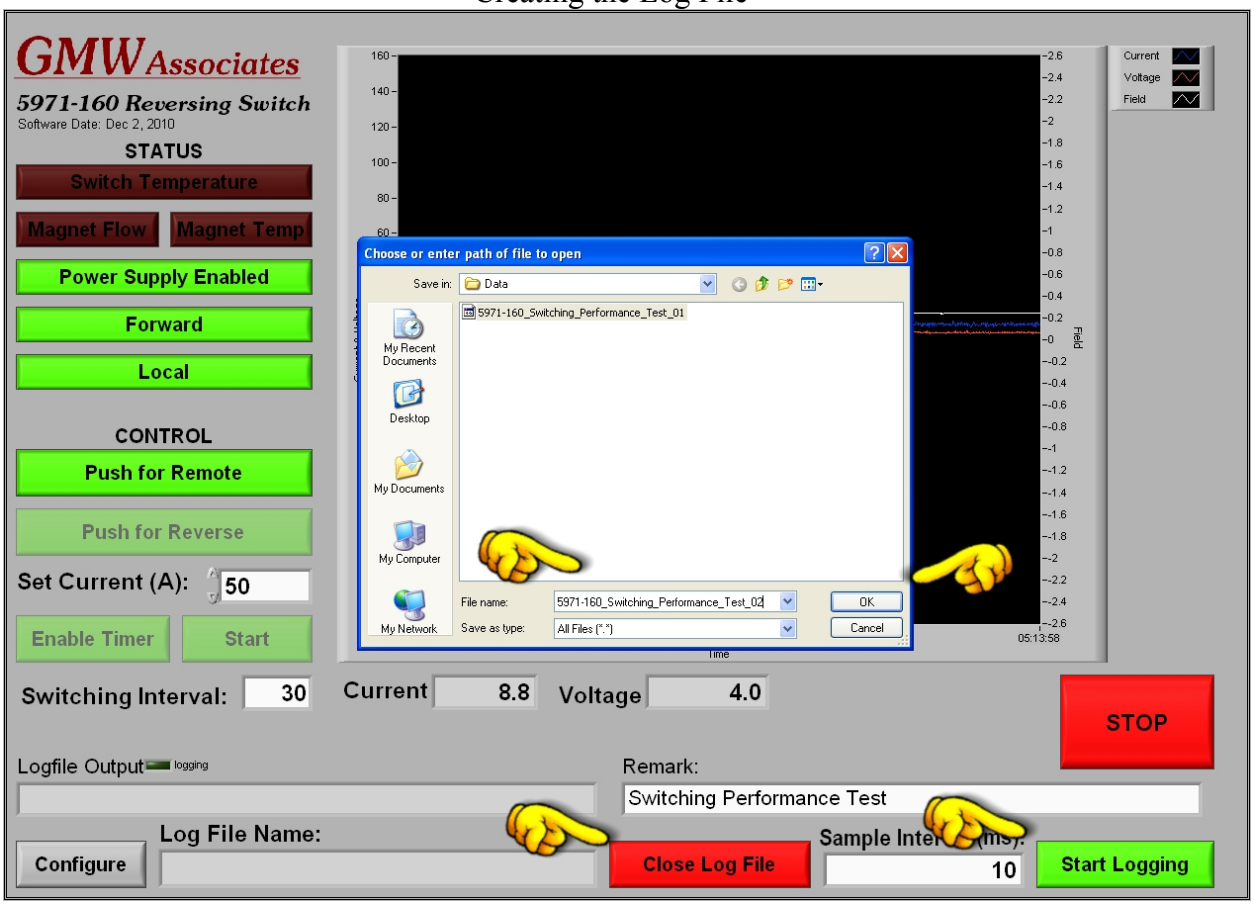
*Note at this time, data is NOT being logged.*

3. To start the logging, click on the green 'Start Logging' button. The button will then change to a red 'Pause Logging' Button.

4. To stop or pause the logging, click on the red 'Pause Logging' button. The button will change back to the green 'Start Logging' button.

5. To close the log file, click on the 'Close Log File' button.

Creating the Log File

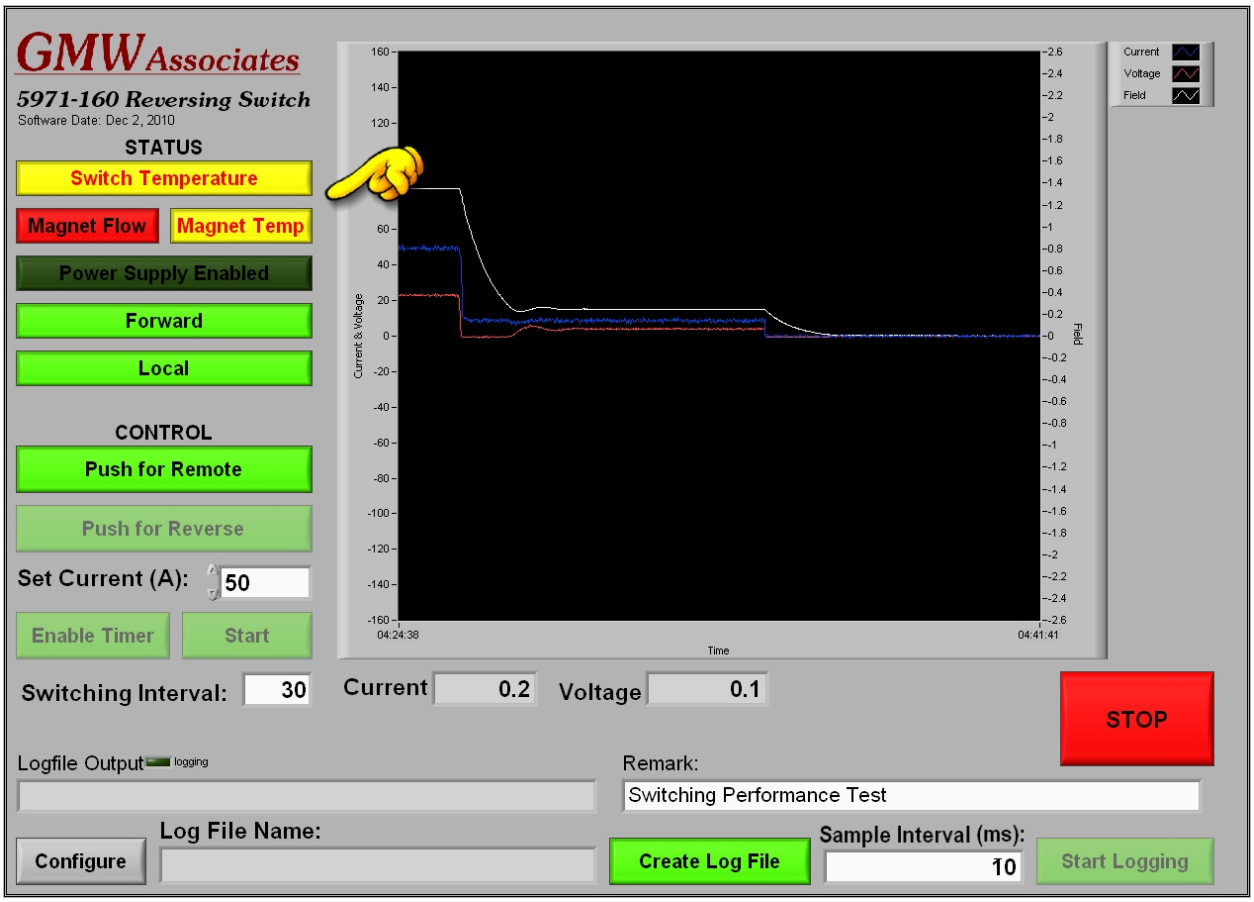


### 5.2.9 - Status Read Back

This software will read back the Reversal Switch status regardless of its Local / Remote status. The status read back consists of three interlock indicators and the general status indicators.

If any one of the interlock conditions exists, the corresponding indicator will flash on the screen and the DC Power Supply's output will be disabled.

Interlock and Status Indicators



## Section 6

## MAINTENANCE

The 5971-160 Current Reversal Switch should operate for many years without any trouble provided that the following basic maintenance points are observed. Always remember that the AC power should be disconnected before performing any maintenance procedure. The 5971-160 may generate lethal voltages and must not be operated with damaged components, protective covers or cable insulation. For more information, please refer to Section 2, Warnings

**1. Electrical Connections:** Ensure that all electrical connections are clean and tight. Ensure that the insulation of all electrical cables is undamaged and repair or replace if necessary. All electrical termination covers must be in place and firmly secured.

**A corroded and / or loose high current connection will cause a voltage drop across the connection. A drop of 0.1V at 160A results in 16W being dissipated at the connection. The connection will increase in temperature which will result in oxidation or the connection, a higher resistance and a further increase in power dissipation. If this situation is left uncorrected the cable and Reversal Switch insulation will melt and possibly the copper connections will melt as well. Not only will the Reversal Switch and nearby equipment be damaged, but there is the possibility for fire.**

**2. Warning Labels:** Ensure that all protective covers on the system and the magnet are in place. There are warning labels on all removable covers.

**3. Cooling:** Check that the fans are clean and free of blockage. Ensure that the fans are operating at full efficiency.

**4. Cleaning:** To clean wipe the case with a soft cloth with a mild detergent or plain water. Do not use any solvents as they may damage the finish.

## Section 7

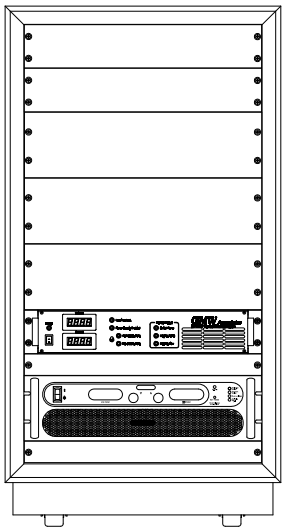
## DRAWINGS

PROPRIETARY
THIS DRAWING CONTAINS CONFIDENTIAL INFORMATION PROPRIETARY TO GMW INC. IT MUST NOT BE REPRODUCED OR DISCLOSED TO OTHERS OR USED IN ANY OTHER WAY, IN WHOLE OR IN PART EXCEPT AS AUTHORIZED IN WRITING BY GMW INC.

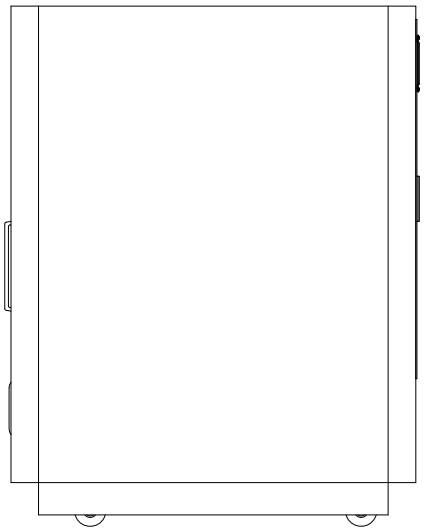
| REVISIONS | | | | |
|---|---|---|---|---|
| REV | DESCRIPTION | DRAFT | DATE | APPROVED |
| A | RELEASE | | 9 Nov, 2010 | M. Duffy |

SIDE VIEW

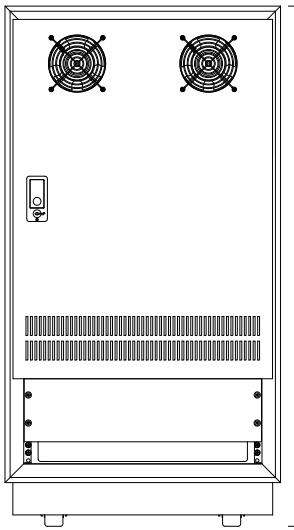
FRONT VIEW



SIDE VIEW



REAR VIEW



1058.0 (41.6")

2U FILLER PANEL

2U FILLER PANEL

3U FILLER PANEL

3U FILLER PANEL

3U FILLER PANEL

5971-160 REVERSING SWITCH

1U FILLER PANEL

SORENSEN SGA SERIES
DC POWER SUPPLY

1U FILLER PANEL

560.5 (22")

823.0 (32.4")

RACK MODEL: OPTIMA RC-351930

APPROX. WEIGHT: 135kg (300lbs) System with SGA 160/31 DC Power Supply
141kg (314lbs) System with SGA 160/63 DC Power Supply

| ITEM | QTY | PART NUMBER | DESCRIPTION | NOTE |
|---|---|---|---|---|

PARTS LIST

| | | |
|---|---|---|
| DRAWN NTS | DATE 9 Nov, 2010 | DO NOT SCALE FROM DRAWING DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED) |
| CHECK M. Duffy | DATE 9 Nov, 2010 | |
| ENGINEERING M. Duffy | DATE 9 Nov, 2010 | |

| LINEAR | INCHES | mm |
|---|---|---|
| X.XXX | ±.005 | ±0.03 |
| X.XX | ±.01 | ±0.1 |
| X.X | ±.03 | ±0.3 |
| X | ±.06 | ±1 |
| DEG. | ±.5 | ±0.5 |
| FINISH | 63 | 1.6 |

THIRD ANGLE PROJECTION

NEXT ASSY | SYSTEM

SOFTWARE AUTOCAD 2000

GMW
955 Industrial Rd, San Carlos, CA 94070
Tel: (650)802-8292. Fax: (650)802-8298.

TITLE: 5971-160 MOSFET Reversing Switch – Rack Assembly

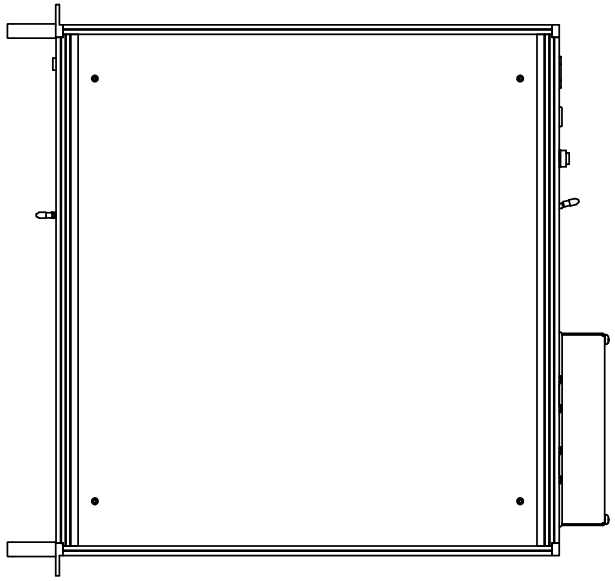
| SIZE | DRAWING NO. | REV |
|---|---|---|
| A1 | 11907-0154-0 | A |

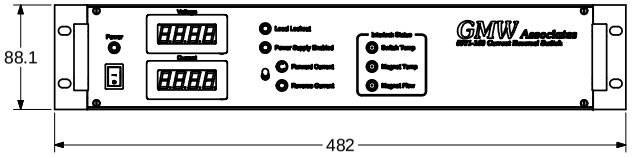
SCALE 1:5 | WT kg | SHEET 1 OF 1

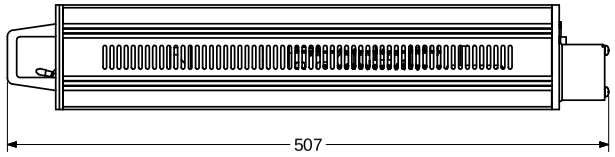
**PROPRIETARY**
THIS DRAWING CONTAINS CONFIDENTIAL INFORMATION PROPRIETARY TO GMW INC. IT MUST NOT BE REPRODUCED OR DISCLOSED TO OTHERS OR USED IN ANY OTHER WAY, IN WHOLE OR IN PART EXCEPT AS AUTHORIZED IN WRITING BY GMW INC.

REVISION HISTORY

| ZONE | REV | DESCRIPTION | DATE | APPROVED |
|---|---|---|---|---|
| | A | Release | 10/20/2009 | Michael E. Duffy |
| | B | Update Front Panel | 02/23/2010 | Michael E. Duffy |
| | C | Update Rear Panel Text | 11/22/2010 | Michael E. Duffy |





Weight: 15.75kg (35Lbs)
Power Input: 115-220VAC, 50/60 Hz, 2A
Max Switched Power: 200V, 160A

| | |
|---|---|
| DRAWN M. Duffy | Date 20 Oct, 2009 |
| CHECK M. Duffy | Date 20 Oct, 2009 |
| ENGINEERING M. Duffy | Date 20 Oct, 2009 |

DO NOT SCALE FROM DRAWING
DIMENSIONS & TOLERANCES UNLESS OTHERWISE SPECIFIED

| LINEAR | INCHES | mm |
|---|---|---|
| X.XXX | ±.005 | ±0.03 |
| X.XX | ± .0 | ± 0.1 |
| X.X | ± .0 | ±0.3 |
| X | ±.06 | ±1 |
| DEG | ±.5 | ±0.5 |
| FINISH | 63 | 1.6 |

THIRD ANGLE PROJECTION

*GMW Associates*
955 Industrial Road, San Carlos, CA 94070
Tel: (650) 802-8292. Fax: (650) 802-8298

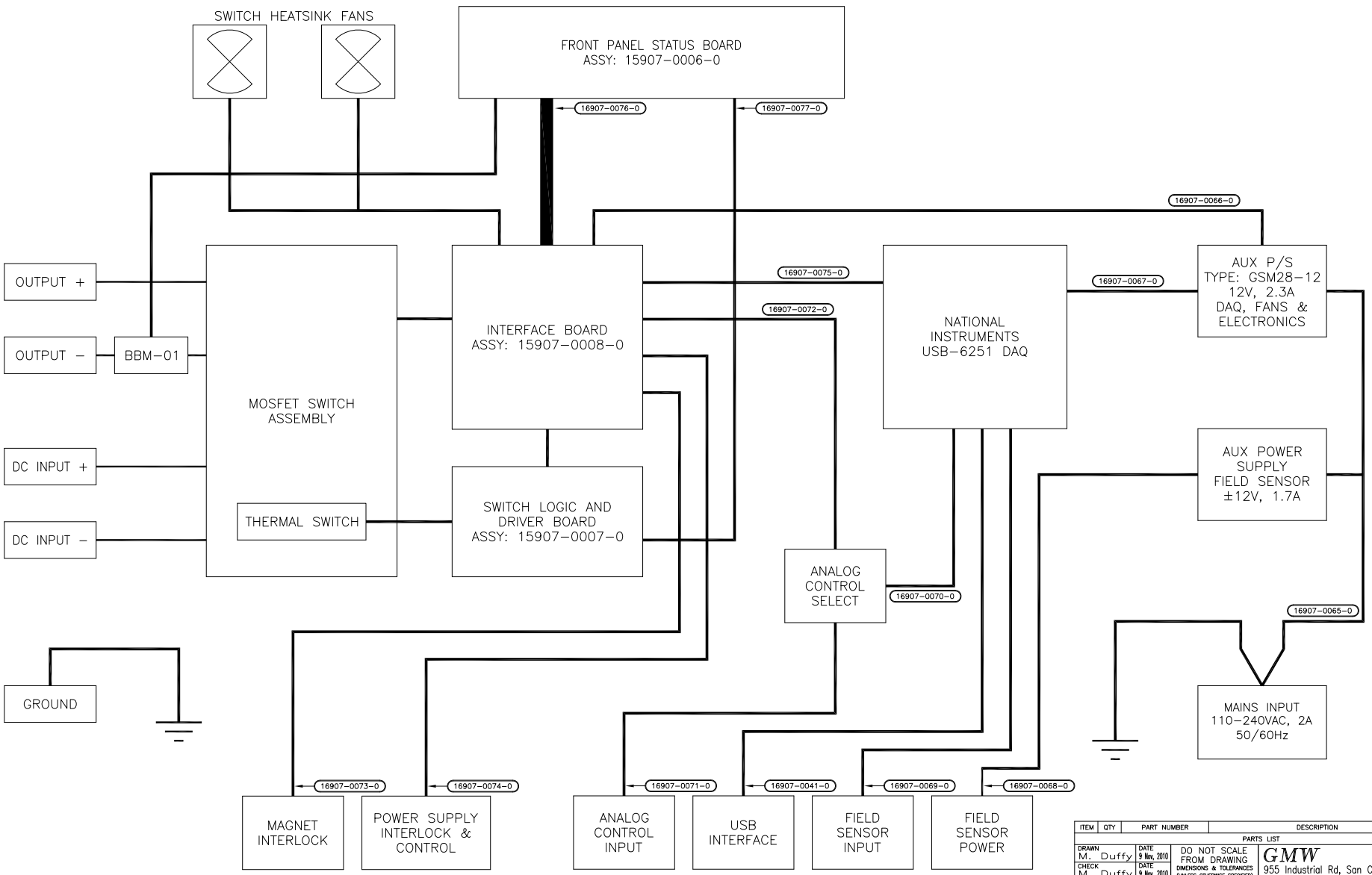
TITLE: 5971-160 MOSFET Reversing Switch - General Assembly

| SIZE | DRAWING No. | REV |
|---|---|---|
| A2 | 11907-0153-0 | C |

SCALE: NTS | WT: ~ kg | SHEET: ~ OF: ~

PROPRIETARY
THIS DRAWING CONTAINS CONFIDENTIAL INFORMATION PROPRIETARY TO GMW INC. IT MUST NOT BE REPRODUCED OR DISCLOSED TO OTHERS OR USED IN ANY OTHER WAY, IN WHOLE OR IN PART EXCEPT AS AUTHORIZED IN WRITING BY GMW INC.

| REVISIONS | | | | |
|---|---|---|---|---|
| REV | DESCRIPTION | DRAFT | DATE | APPROVED |
| A | RELEASE | | 9 Nov, 2010 | M. Duffy |




| ITEM | QTY | PART NUMBER | DESCRIPTION | NOTE |
|---|---|---|---|---|

PARTS LIST

| | | |
|---|---|---|
| DRAWN M. Duffy | DATE 9 Nov, 2010 | DO NOT SCALE FROM DRAWING |
| CHECK M. Duffy | DATE 9 Nov, 2010 | DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED) |
| ENGINEERING M. Duffy | DATE 9 Nov, 2010 | |

| LINEAR | INCHES | mm |
|---|---|---|
| X.XXX | ±.005 | ±0.03 |
| X.XX | ±.01 | ±0.1 |
| X.X | ±.03 | ±0.3 |
| X | ±.06 | ±1 |
| DEG. | ±.5 | ±0.5 |
| FINISH | 63 | 1.6 |

THIRD ANGLE PROJECTION

NEXT ASSY | SYSTEM

SOFTWARE
AUTOCAD 2000

GMW
955 Industrial Rd, San Carlos, CA 94070
Tel: (650)802-8292. Fax: (650)802-8298.

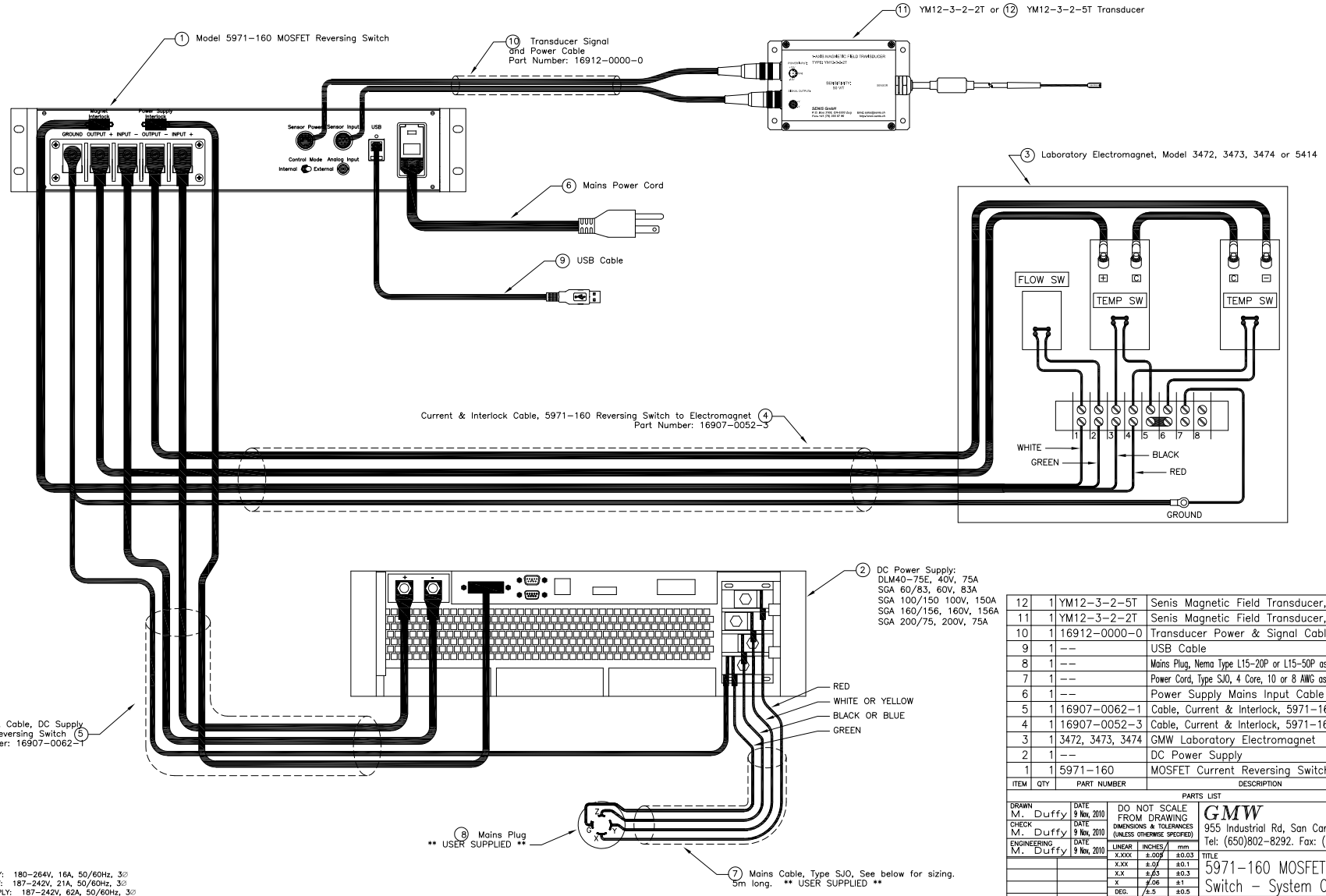
TITLE
5971-160 MOSFET Reversing Switch Block Diagram

| SIZE | DRAWING NO. | REV |
|---|---|---|
| A1 | 13907-0008-0 | A |

SCALE | WT kg | SHEET 1 OF 1

PROPRIETARY
THIS DRAWING CONTAINS CONFIDENTIAL INFORMATION PROPRIETARY TO GMW INC. IT MUST NOT BE REPRODUCED OR DISCLOSED TO OTHERS OR USED IN ANY OTHER WAY, IN WHOLE OR IN PART EXCEPT AS AUTHORIZED IN WRITING BY GMW INC.

| REVISIONS | | | | |
|---|---|---|---|---|
| REV | DESCRIPTION | DRAFT | DATE | APPROVED |
| A | RELEASE | | 9 Nov, 2010 | M. Duffy |


(1) Model 5971–160 MOSFET Reversing Switch
(10) Transducer Signal and Power Cable Part Number: 16912–0000–0
(11) YM12–3–2–2T or (12) YM12–3–2–5T Transducer
(3) Laboratory Electromagnet, Model 3472, 3473, 3474 or 5414
(6) Mains Power Cord
(9) USB Cable
Current & Interlock Cable, 5971–160 Reversing Switch to Electromagnet (4) Part Number: 16907–0052–3
(2) DC Power Supply:
DLM40–75E, 40V, 75A
SGA 60/83, 60V, 83A
SGA 100/150 100V, 150A
SGA 160/156, 160V, 156A
SGA 200/75, 200V, 75A
Current & Interlock Cable, DC Supply to 5971–160 Reversing Switch (5) Part Number: 16907–0062–1
(8) Mains Plug ** USER SUPPLIED **
(7) Mains Cable, Type SJO, See below for sizing. 5m long. ** USER SUPPLIED **
FLOW SW
TEMP SW
TEMP SW
WHITE
GREEN
BLACK
RED
GROUND
RED
WHITE OR YELLOW
BLACK OR BLUE
GREEN

MAINS INPUT:
DLM40–75E DC POWER SUPPLY: 180–264V, 16A, 50/60Hz, 3Ø
SGA 60/83 DC POWER SUPPLY: 187–242V, 21A, 50/60Hz, 3Ø
SGA 100/150 DC POWER SUPPLY: 187–242V, 62A, 50/60Hz, 3Ø
SGA 160/156 DC POWER SUPPLY: 187–242V, 103A, 50/60Hz, 3Ø
SGA 200/75 DC POWER SUPPLY: 187–242V, 103A, 50/60Hz, 3Ø

| ITEM | QTY | PART NUMBER | DESCRIPTION | NOTE |
|---|---|---|---|---|
| 12 | 1 | YM12–3–2–5T | Senis Magnetic Field Transducer, 5T | |
| 11 | 1 | YM12–3–2–2T | Senis Magnetic Field Transducer, 2T | |
| 10 | 1 | 16912–0000–0 | Transducer Power & Signal Cable | |
| 9 | 1 | –– | USB Cable | |
| 8 | 1 | –– | Mains Plug, Nema Type L15–20P or L15–50P as appropriate | |
| 7 | 1 | –– | Power Cord, Type SJO, 4 Core, 10 or 8 AWG as appropriate | |
| 6 | 1 | –– | Power Supply Mains Input Cable | |
| 5 | 1 | 16907–0062–1 | Cable, Current & Interlock, 5971–160 In | |
| 4 | 1 | 16907–0052–3 | Cable, Current & Interlock, 5971–160 Out | |
| 3 | 1 | 3472, 3473, 3474 | GMW Laboratory Electromagnet | |
| 2 | 1 | –– | DC Power Supply | |
| 1 | 1 | 5971–160 | MOSFET Current Reversing Switch | |

PARTS LIST

| | | |
|---|---|---|
| DRAWN M. Duffy | DATE 9 Nov, 2010 | DO NOT SCALE FROM DRAWING |
| CHECK M. Duffy | DATE 9 Nov, 2010 | DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED) |
| ENGINEERING M. Duffy | DATE 9 Nov, 2010 | |

| LINEAR | INCHES | mm |
|---|---|---|
| X.XXX | ±.005 | ±0.03 |
| X.XX | ±.01 | ±0.1 |
| X.X | ±.03 | ±0.3 |
| X | ±.06 | ±1 |
| DEG. | ±.5 | ±0.5 |
| FINISH | 63 | 1.6 |

NEXT ASSY | SYSTEM
SOFTWARE AUTOCAD 2000
THIRD ANGLE PROJECTION

GMW
955 Industrial Rd, San Carlos, CA 94070
Tel: (650)802–8292. Fax: (650)802–8298.

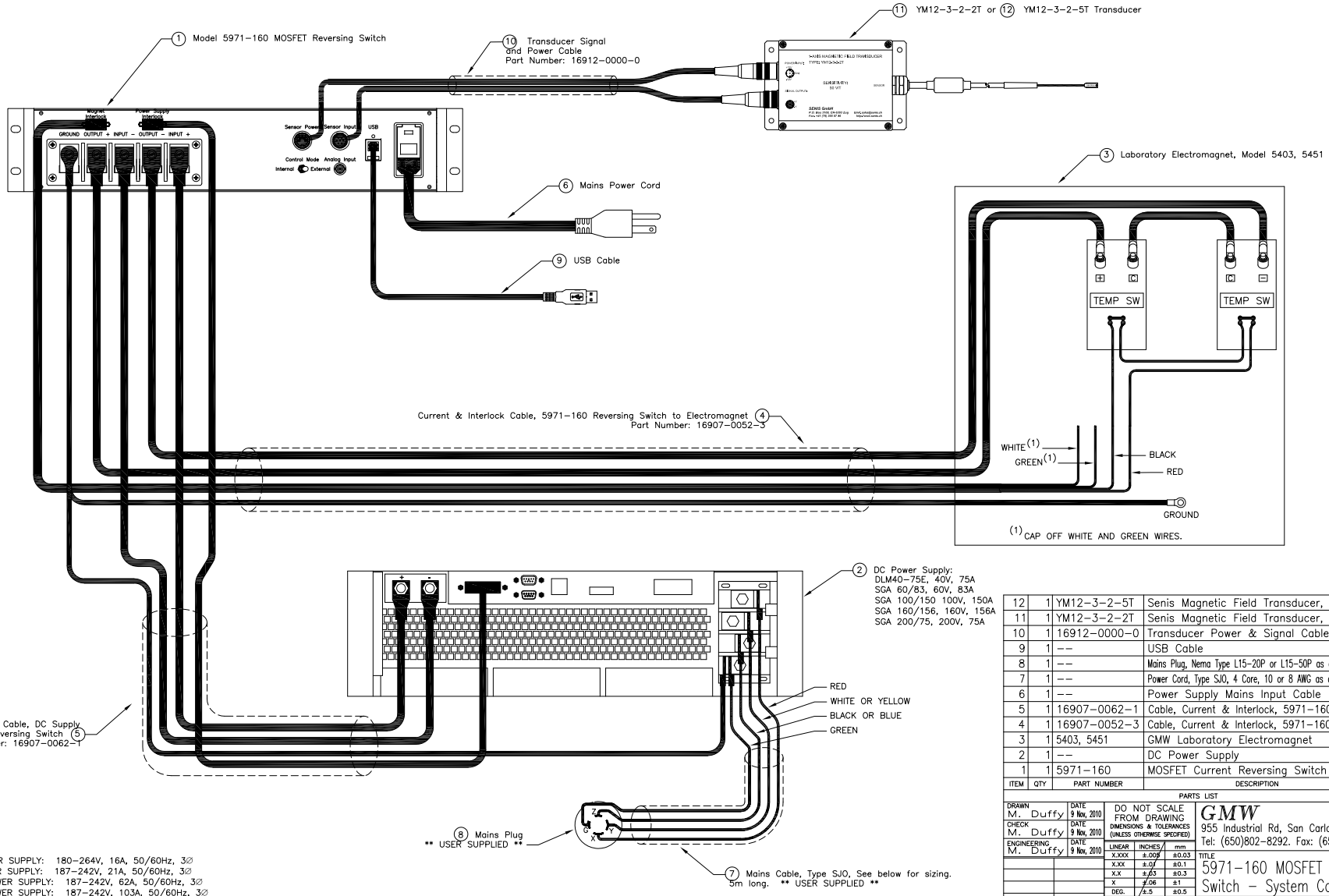
TITLE: 5971–160 MOSFET Reversing Switch – System Connections

| SIZE | DRAWING NO. | REV |
|---|---|---|
| A1 | 13907–0009–0 | A |

SCALE | WT kg | SHEET 1 OF 1

PROPRIETARY
THIS DRAWING CONTAINS CONFIDENTIAL INFORMATION PROPRIETARY TO GMW INC. IT MUST NOT BE REPRODUCED OR DISCLOSED TO OTHERS OR USED IN ANY OTHER WAY, IN WHOLE OR IN PART EXCEPT AS AUTHORIZED IN WRITING BY GMW INC.

| REVISIONS | | | | |
|---|---|---|---|---|
| REV | DESCRIPTION | DRAFT | DATE | APPROVED |
| A | RELEASE | | 9 Nov, 2010 | M. Duffy |


1 Model 5971–160 MOSFET Reversing Switch
10 Transducer Signal and Power Cable Part Number: 16912–0000–0
11 YM12–3–2–2T or 12 YM12–3–2–5T Transducer
3 Laboratory Electromagnet, Model 5403, 5451
6 Mains Power Cord
9 USB Cable
TEMP SW
TEMP SW
Current & Interlock Cable, 5971–160 Reversing Switch to Electromagnet 4 Part Number: 16907–0052–3
WHITE (1)
GREEN (1)
BLACK
RED
GROUND
(1) CAP OFF WHITE AND GREEN WIRES.
2 DC Power Supply:
DLM40–75E, 40V, 75A
SGA 60/83, 60V, 83A
SGA 100/150 100V, 150A
SGA 160/156, 160V, 156A
SGA 200/75, 200V, 75A
RED
WHITE OR YELLOW
BLACK OR BLUE
GREEN
Current & Interlock Cable, DC Supply to 5971–160 Reversing Switch 5 Part Number: 16907–0062–1
8 Mains Plug ** USER SUPPLIED **
7 Mains Cable, Type SJO, See below for sizing. 5m long. ** USER SUPPLIED **

MAINS INPUT:
DLM40–75E DC POWER SUPPLY: 180–264V, 16A, 50/60Hz, 3Ø
SGA 60/83 DC POWER SUPPLY: 187–242V, 21A, 50/60Hz, 3Ø
SGA 100/150 DC POWER SUPPLY: 187–242V, 62A, 50/60Hz, 3Ø
SGA 160/156 DC POWER SUPPLY: 187–242V, 103A, 50/60Hz, 3Ø
SGA 200/75 DC POWER SUPPLY: 187–242V, 103A, 50/60Hz, 3Ø

| ITEM | QTY | PART NUMBER | DESCRIPTION | NOTE |
|---|---|---|---|---|
| 12 | 1 | YM12–3–2–5T | Senis Magnetic Field Transducer, 5T | |
| 11 | 1 | YM12–3–2–2T | Senis Magnetic Field Transducer, 2T | |
| 10 | 1 | 16912–0000–0 | Transducer Power & Signal Cable | |
| 9 | 1 | –– | USB Cable | |
| 8 | 1 | –– | Mains Plug, Nema Type L15–20P or L15–50P as appropriate | |
| 7 | 1 | –– | Power Cord, Type SJO, 4 Core, 10 or 8 AWG as appropriate | |
| 6 | 1 | –– | Power Supply Mains Input Cable | |
| 5 | 1 | 16907–0062–1 | Cable, Current & Interlock, 5971–160 In | |
| 4 | 1 | 16907–0052–3 | Cable, Current & Interlock, 5971–160 Out | |
| 3 | 1 | 5403, 5451 | GMW Laboratory Electromagnet | |
| 2 | 1 | –– | DC Power Supply | |
| 1 | 1 | 5971–160 | MOSFET Current Reversing Switch | |

PARTS LIST

| | | |
|---|---|---|
| DRAWN M. Duffy | DATE 9 Nov, 2010 | DO NOT SCALE FROM DRAWING DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED) |
| CHECK M. Duffy | DATE 9 Nov, 2010 | |
| ENGINEERING M. Duffy | DATE 9 Nov, 2010 | |

| LINEAR | INCHES | mm |
|---|---|---|
| X.XXX | ±.005 | ±0.03 |
| X.XX | ±.01 | ±0.1 |
| X.X | ±.03 | ±0.3 |
| X | ±.06 | ±1 |
| DEG. | ±.5 | ±0.5 |
| FINISH | 63 | 1.6 |

NEXT ASSY | SYSTEM
SOFTWARE AUTOCAD 2000
THIRD ANGLE PROJECTION

GMW
955 Industrial Rd, San Carlos, CA 94070
Tel: (650)802–8292. Fax: (650)802–8298.

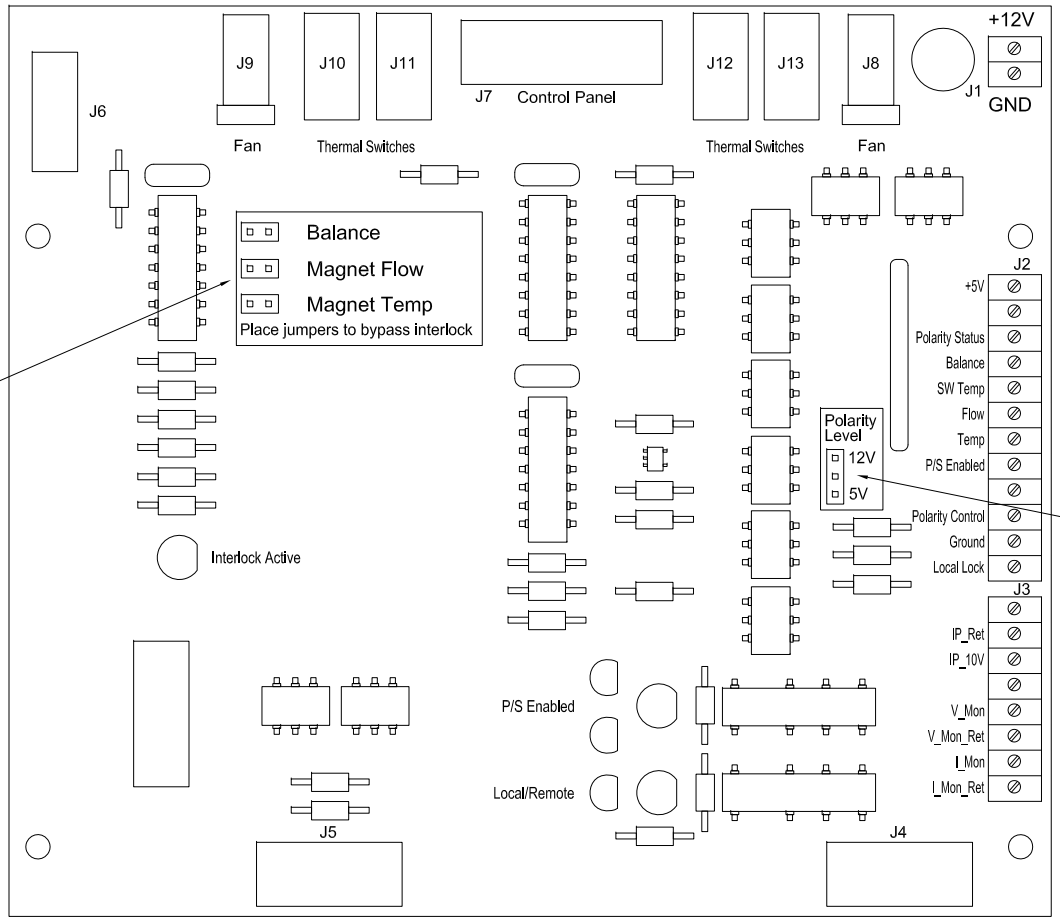
TITLE: 5971–160 MOSFET Reversing Switch – System Connections

| SIZE | DRAWING NO. | REV |
|---|---|---|
| A1 | 13907–0009–1 | A |

SCALE | WT kg | SHEET 1 OF 1

PROPRIETARY
THIS DRAWING CONTAINS CONFIDENTIAL INFORMATION PROPRIETARY TO GMW INC. IT MUST NOT BE REPRODUCED OR DISCLOSED TO OTHERS OR USED IN ANY OTHER WAY, IN WHOLE OR IN PART EXCEPT AS AUTHORIZED IN WRITING BY GMW INC.

| REVISIONS | | | | |
|---|---|---|---|---|
| REV | DESCRIPTION | DRAFT | DATE | APPROVED |
| A | RELEASE | | 9 Nov, 2010 | M. Duffy |




INSTALL JUMPER TO BYPASS INTERLOCK FUNCTION.

NOTE: 'BALANCE' IS UNUSED AT THIS TIME, AND THE JUMPER MUST BE IN PLACE.

USE JUMPER TO SELECT THE POLARITY CONTROL VOLTAGE LEVEL.

| ITEM | QTY | PART NUMBER | DESCRIPTION | NOTE |
|---|---|---|---|---|

PARTS LIST

| | | |
|---|---|---|
| DRAWN M. Duffy | DATE 9 Nov, 2010 | DO NOT SCALE FROM DRAWING |
| CHECK M. Duffy | DATE 9 Nov, 2010 | DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED) |
| ENGINEERING M. Duffy | DATE 9 Nov, 2010 | |

| LINEAR | INCHES | mm |
|---|---|---|
| X.XXX | ±.005 | ±0.03 |
| X.XX | ±.01 | ±0.1 |
| X.X | ±.03 | ±0.3 |
| X | ±.06 | ±1 |
| DEG. | ±.5 | ±0.5 |
| FINISH | 63 | 1.6 |

NEXT ASSY | SYSTEM

SOFTWARE AUTOCAD 2000

THIRD ANGLE PROJECTION

GMW
955 Industrial Rd, San Carlos, CA 94070
Tel: (650)802-8292. Fax: (650)802-8298.

TITLE
5971-160 MOSFET Reversal Switch - Jumper Configuration

| SIZE | DRAWING NO. | REV |
|---|---|---|
| A1 | 1X907-0000-0 | A |

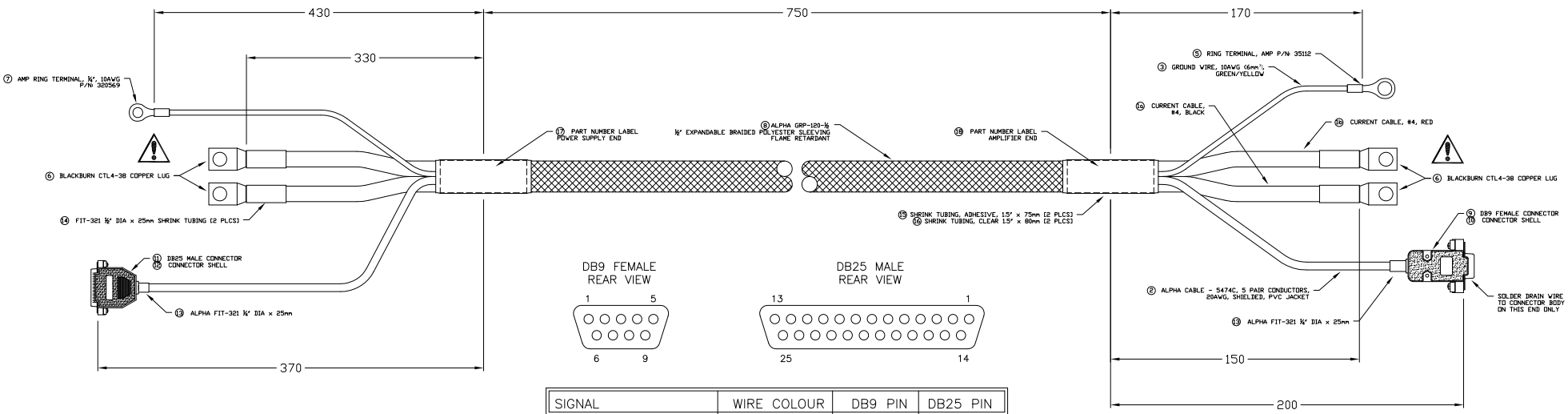
SCALE | WT kg | SHEET 1 OF 1

PROPRIETARY
THIS DRAWING CONTAINS CONFIDENTIAL INFORMATION PROPRIETARY TO GMW INC. IT MUST NOT BE REPRODUCED OR DISCLOSED TO OTHERS OR USED IN ANY OTHER WAY, IN WHOLE OR IN PART EXCEPT AS AUTHORIZED IN WRITING BY GMW INC.

| REVISIONS | | | | |
|---|---|---|---|---|
| REV | DESCRIPTION | DRAFT | DATE | APPROVED |
| A | RELEASE | | 9 Nov, 2010 | M. Duffy |

"A" END
CONNECT TO SGA DC POWER SUPPLY

"B" END
CONNECT TO 5971-160
REVERSAL SWITCH


430
330
750
170
⑦ AMP RING TERMINAL, ¼", 10AWG P/N 320569
⑥ BLACKBURN CTL4-38 COPPER LUG
⑭ FIT-321 ½" DIA x 25mm SHRINK TUBING (2 PLCS)
⑪ DB25 MALE CONNECTOR
⑮ CONNECTOR SHELL
⑬ ALPHA FIT-321 ¼" DIA x 25mm
370
⑰ PART NUMBER LABEL POWER SUPPLY END
⑧ ALPHA GRP-120-½ ½" EXPANDABLE BRAIDED POLYESTER SLEEVING FLAME RETARDANT
⑱ PART NUMBER LABEL AMPLIFIER END
⑮ SHRINK TUBING, ADHESIVE, 1.5" x 75mm (2 PLCS)
⑯ SHRINK TUBING, CLEAR 1.5" x 80mm (2 PLCS)
⑤ RING TERMINAL, AMP P/N 35112
③ GROUND WIRE, 10AWG (6mm²) GREEN/YELLOW
1a CURRENT CABLE, #4, BLACK
16 CURRENT CABLE, #4, RED
⑥ BLACKBURN CTL4-38 COPPER LUG
⑨ DB9 FEMALE CONNECTOR
⑯ CONNECTOR SHELL
② ALPHA CABLE - 5474C, 5 PAIR CONDUCTORS, 20AWG, SHIELDED, PVC JACKET
⑬ ALPHA FIT-321 ¼" DIA x 25mm
SOLDER DRAIN WIRE TO CONNECTOR BODY ON THIS END ONLY
150
200
DB9 FEMALE
REAR VIEW
1 5
6 9
DB25 MALE
REAR VIEW
13 1
25 14

| SIGNAL | WIRE COLOUR | DB9 PIN | DB25 PIN |
|---|---|---|---|
| PS ON/OFF COMMON | BLACK | 9 | 24 |
| PS ON/OFF CONTACT | RED | 8 | 5 |
| CURRENT MONITOR | WHITE | 3 | 7 |
| CURRENT MONITOR RTN | BLACK | 4 | 6 |
| VOLTAGE MONITOR | BLUE | 6 | 19 |
| VOLTAGE MONITOR RTN | BLACK | 7 | 6 |
| CURRENT PROG. 10V | YELLOW | 1 | 16 |
| CURRENT PROG. RTN | BLACK | 2 | 23 |
| COMMON | GREEN | 5 | 24 |

CUT LENGTHS:
- CURRENT CABLE – 1230mm
- GROUND – 1350mm
- INTERLOCK – 1320mm

⚠ WARNING: THE RED (POSITIVE) TERMINATION OF THE CABLE MUST BE CONNECTED TO THE POSITIVE TERMINALS OF THE DC POWER SUPPLY AND THE 5971-160 REVERSING SWITCH. INCORRECT CONNECTION WILL DAMAGE THE REVERSING SWITCH, VOIDING THE WARRANTY.

NOTE:
1. REFER TO DRAWING 169XX-0000-0 FOR BASIC CABLE ASSEMBLY
2. MAXIMUM CONTINUOUS CURRENT: 70 Amps
3. TOTAL CABLE RESISTANCE: 0.0025 Ohms
4. NOMINAL VOLTAGE DROP @ MAXIMUM CURRENT: 0.18 Volts

| ITEM | QTY | PART NUMBER | DESCRIPTION | NOTE |
|---|---|---|---|---|
| 17 | 1 | 10907-0059-1 | LABEL, REVERSING SWITCH END | |
| 16 | 1 | 10907-0059-0 | LABEL, DC POWER SUPPLY END | |
| 15 | 2 | FIT-221-1-CLEAR | SHRINK TUBING, CLEAR, 1" X 80mm | |
| 14 | 2 | FIT-321-1 | SHRINK TUBING, ADHESIVE WALL, 1" X 75mm | |
| 13 | 1 | FIT-321-1/2 | SHRINK TUBING, ADHESIVE WALL, ½" X 25mm | |
| 12 | 2 | FIT-321-1/4 | SHRINK TUBING, ADHESIVE WALL, ¼" X 25mm | |
| 11 | 1 | C88E321005 | S-SUB 25 PIN CONNECTOR HOOD | |
| 10 | 1 | 5-747912-2 | D-SUB 25 PIN CONNECTOR, MALE, SOLDER CUP | |
| 9 | 1 | C88E301005 | S-SUB 9 PIN CONNECTOR HOOD | |
| 8 | 1 | 5-747905-2 | D-SUB 9 PIN CONNECTOR, FEMALE, SOLDER CUP | |
| 7 | A/R | GRP-120-½ | EXPANDABLE POLYESTER SLEEVING, FLAME RETARDANT | |
| 6 | 1 | 320569 | RING TERMINAL, PIDG, 12 – 10AWG, ¼" STUD | |
| 5 | 2 | CTL4-38 | COPPER COMPRESSION LUG, #4 CABLE, ⅜" STUD | |
| 4 | 1 | 35112 | RING TERMINAL, PIDG, 10AWG, ⅜" STUD | |
| 3 | A/R | 86026030 | GROUND WIRE, 6mm², GREEN/YELLOW | |
| 2 | A/R | 5475C | CABLE, 5 PAIR, SHIELDED, 20AWG, PVC JACKET | |
| 1b | A/R | A2004B-01 | CABLE, COBRA X-FLEX, #4, RED INSULATION | |
| 1a | A/R | A2004B-07 | CABLE, COBRA X-FLEX, #4, BLACK INSULATION | |

PARTS LIST

| | | |
|---|---|---|
| DRAWN M. Duffy | DATE 9 Nov, 2010 | DO NOT SCALE FROM DRAWING |
| CHECK M. Duffy | DATE 9 Nov, 2010 | DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED) |
| ENGINEERING M. Duffy | DATE 9 Nov, 2010 | |
| NEXT ASSY | SYSTEM | |
| SOFTWARE AUTOCAD 2000 | | |

| LINEAR | INCHES | mm |
|---|---|---|
| X.XXX | ±.005 | ±0.03 |
| X.XX | ±.01 | ±0.1 |
| X.X | ±.03 | ±0.3 |
| X | ±.06 | ±1 |
| DEG. | ±.5 | ±0.5 |
| FINISH | 63 ✓ | 1.6 ✓ |

THIRD ANGLE PROJECTION

GMW
955 Industrial Rd, San Carlos, CA 94070
Tel: (650)802-8292. Fax: (650)802-8298.

TITLE
5971-160 MOSFET Reversal Switch to SGA 60-83

| SIZE | DRAWING NO. | REV |
|---|---|---|
| A1 | 16907-0062-1 | A |

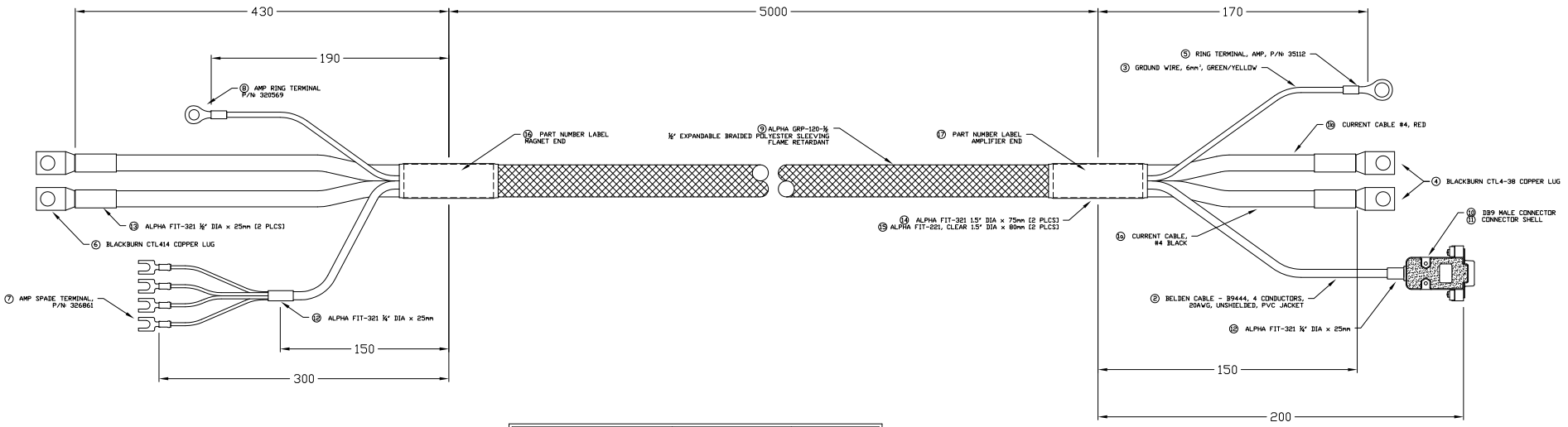
| SCALE | WT kg | SHEET 1 OF 1 |
|---|---|---|

PROPRIETARY
THIS DRAWING CONTAINS CONFIDENTIAL INFORMATION PROPRIETARY TO GMW INC. IT MUST NOT BE REPRODUCED OR DISCLOSED TO OTHERS OR USED IN ANY OTHER WAY, IN WHOLE OR IN PART EXCEPT AS AUTHORIZED IN WRITING BY GMW INC.

| REVISIONS | | | | |
|---|---|---|---|---|
| REV | DESCRIPTION | DRAFT | DATE | APPROVED |
| A | RELEASE | | 9 Nov, 2010 | M. Duffy |

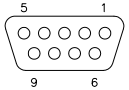
"A" END
CONNECT TO ELECTROMAGNET

"B" END
CONNECT TO 5971-160
REVERSAL SWITCH


430
190
5000
170
300
150
150
200
⑧ AMP RING TERMINAL P/N 320569
⑯ PART NUMBER LABEL MAGNET END
⑨ ALPHA GRP-120-½ ½" EXPANDABLE BRAIDED POLYESTER SLEEVING FLAME RETARDANT
⑰ PART NUMBER LABEL AMPLIFIER END
⑤ RING TERMINAL, AMP, P/N 35112
③ GROUND WIRE, 6mm², GREEN/YELLOW
⑱ CURRENT CABLE #4, RED
④ BLACKBURN CTL4-38 COPPER LUG
⑬ ALPHA FIT-321 ½" DIA x 25mm (2 PLCS)
⑥ BLACKBURN CTL414 COPPER LUG
⑭ ALPHA FIT-321 1.5" DIA x 75mm (2 PLCS)
⑮ ALPHA FIT-221, CLEAR 1.5" DIA x 80mm (2 PLCS)
⑩ DB9 MALE CONNECTOR
⑪ CONNECTOR SHELL
1a CURRENT CABLE, #4 BLACK
⑦ AMP SPADE TERMINAL, P/N 326861
⑫ ALPHA FIT-321 ¼" DIA x 25mm
② BELDEN CABLE - B9444, 4 CONDUCTORS, 20AWG, UNSHIELDED, PVC JACKET
⑫ ALPHA FIT-321 ¼" DIA x 25mm

| SIGNAL | WIRE COLOUR | DB9 PIN |
|---|---|---|
| TEMP. INTLK. OUT | BLACK | 1 |
| TEMP. INTLK. RETN | RED | 9 |
| FLOW INTLK. OUT | GREEN | 5 |
| FLOW INTLK. RETN | WHITE | 6 |

DB9 MALE
REAR VIEW




REFER TO DRAWINGS 13907-0009-0 & 13907-0009-1 FOR INTERLOCK TERMINATIONS ON THE ELECTROMAGNET.

CUT LENGTHS:
- CURRENT CABLE – 5580mm
- GROUND – 5360mm
- INTERLOCK – 5500mm

NOTE:
1. REFER TO DRAWING 169XX-0000-0 FOR BASIC CABLE ASSEMBLY
2. MAXIMUM CONTINUOUS CURRENT: 70 Amps
3. TOTAL CABLE RESISTANCE: 0.0115 Ohms
4. NOMINAL VOLTAGE DROP @ MAXIMUM CURRENT: 0.81 Volts

| ITEM | QTY | PART NUMBER | DESCRIPTION | NOTE |
|---|---|---|---|---|
| 17 | 1 | 10907-0059-1 | LABEL, AMPLIFIER END | |
| 16 | 1 | 10907-0059-0 | LABEL, MAGNET END | |
| 15 | 2 | FIT-221-1-CLEAR | SHRINK TUBING, CLEAR, 1" X 80mm | |
| 14 | 2 | FIT-321-1 | SHRINK TUBING, ADHESIVE WALL, 1" X 75mm | |
| 13 | 1 | FIT-321-1/2 | SHRINK TUBING, ADHESIVE WALL, ½" X 25mm | |
| 12 | 2 | FIT-321-1/4 | SHRINK TUBING, ADHESIVE WALL, ¼" X 25mm | |
| 11 | 1 | C88E301005 | S-SUB 9 PIN CONNECTOR HOOD | |
| 10 | 1 | 5-747904-2 | D-SUB 9 PIN CONNECTOR, MALE, SOLDER CUP | |
| 9 | A/R | GRP-120-½ | EXPANDABLE POLYESTER SLEEVING, FLAME RETARDANT | |
| 8 | 1 | 320569 | RING TERMINAL, #¼", 12 – 10AWG | |
| 7 | 4 | 326861 | FORK TERMINAL, #6, 22 – 16AWG | |
| 6 | 2 | CTL414 | COPPER COMPRESSION LUG, #4 CABLE, ¼" STUD | |
| 5 | 1 | 35112 | RING TERMINAL, PIDG, 10AWG, ⅜" STUD | |
| 4 | 2 | CTL4-38 | COPPER COMPRESSION LUG, #4 CABLE, ⅜" STUD | |
| 3 | A/R | 86026030 | GROUND WIRE, 6mm², GREEN/YELLOW | |
| 2 | A/R | B9444 | CABLE, 4 CONDUCTORS, 20AWG, PVC JACKET | |
| 1b | A/R | A2004B-02 | CABLE, COBRA X-FLEX, #4, RED INSULATION | |
| 1a | A/R | A2004B-07 | CABLE, COBRA X-FLEX, #4, BLACK INSULATION | |

PARTS LIST

| | | |
|---|---|---|
| DRAWN M. Duffy | DATE 9 Nov, 2010 | DO NOT SCALE FROM DRAWING |
| CHECK M. Duffy | DATE 9 Nov, 2010 | DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED) |
| ENGINEERING M. Duffy | DATE 9 Nov, 2010 | |
| NEXT ASSY | SYSTEM | |
| SOFTWARE AUTOCAD 2000 | | |

| LINEAR | INCHES | mm |
|---|---|---|
| X.XXX | ±.005 | ±0.03 |
| X.XX | ±.01 | ±0.1 |
| X.X | ±.03 | ±0.3 |
| X | ±.06 | ±1 |
| DEG. | ±.5 | ±0.5 |
| FINISH | 63 ✓ | 1.6 ✓ |

THIRD ANGLE PROJECTION

GMW
955 Industrial Rd, San Carlos, CA 94070
Tel: (650)802-8292. Fax: (650)802-8298.

TITLE
5971-160 MOSFET Reversal Switch to 3473-70

| SIZE | DRAWING NO. | REV |
|---|---|---|
| A1 | 16907-0052-3 | A |

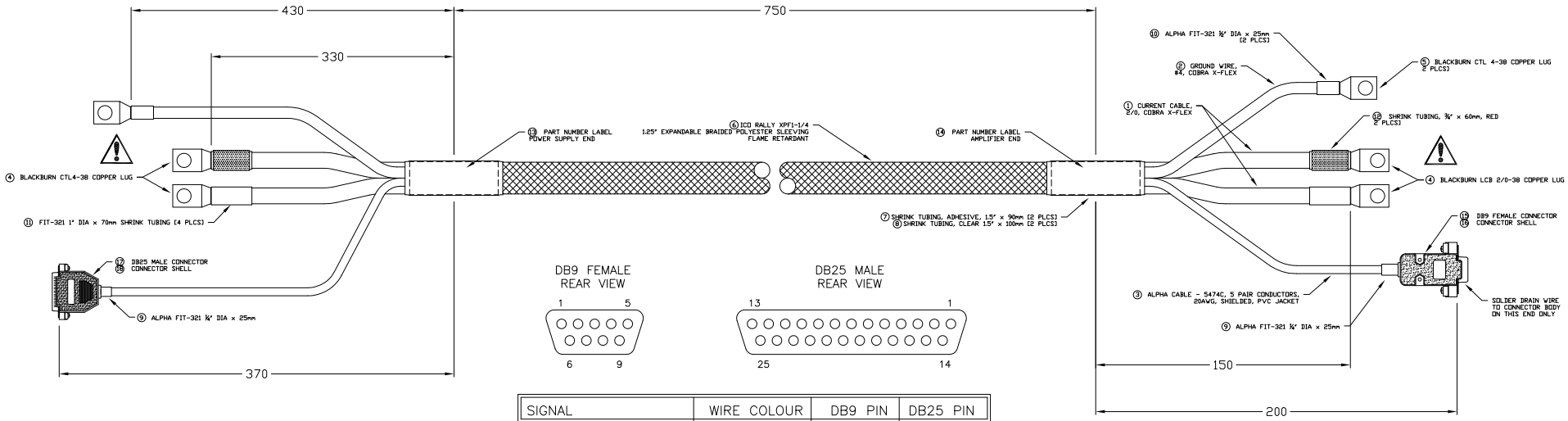
| SCALE | WT kg | SHEET 1 OF 1 |
|---|---|---|

PROPRIETARY
THIS DRAWING CONTAINS CONFIDENTIAL INFORMATION PROPRIETARY TO GMW INC. IT MUST NOT BE REPRODUCED OR DISCLOSED TO OTHERS OR USED IN ANY OTHER WAY, IN WHOLE OR IN PART EXCEPT AS AUTHORIZED IN WRITING BY GMW INC.

| REVISIONS | | | | |
|---|---|---|---|---|
| REV | DESCRIPTION | DRAFT | DATE | APPROVED |
| A | RELEASE | | 9 Dec, 2010 | M. Duffy |

"A" END
CONNECT TO SGA DC POWER SUPPLY

"B" END
CONNECT TO 5971-160
REVERSAL SWITCH


430
330
750
④ BLACKBURN CTL4-38 COPPER LUG
⑪ FIT-321 1" DIA x 70mm SHRINK TUBING (4 PLCS)
⑰ DB25 MALE CONNECTOR SHELL
⑱ CONNECTOR SHELL
⑨ ALPHA FIT-321 ¼" DIA x 25mm
⑬ PART NUMBER LABEL POWER SUPPLY END
⑥ ICD RALLY XPF1-1/4 1.25" EXPANDABLE BRAIDED POLYESTER SLEEVING FLAME RETARDANT
⑭ PART NUMBER LABEL AMPLIFIER END
⑦ SHRINK TUBING, ADHESIVE, 1.5" x 90mm (2 PLCS)
⑧ SHRINK TUBING, CLEAR 1.5" x 100mm (2 PLCS)
⑩ ALPHA FIT-321 ¼" DIA x 25mm (2 PLCS)
② GROUND WIRE, #4, COBRA X-FLEX
⑤ BLACKBURN CTL 4-38 COPPER LUG (2 PLCS)
① CURRENT CABLE, 2/0, COBRA X-FLEX
⑫ SHRINK TUBING, ¾" x 60mm, RED (2 PLCS)
④ BLACKBURN LCB 2/0-38 COPPER LUG
⑱ DB9 FEMALE CONNECTOR SHELL
③ ALPHA CABLE - 5474C, 5 PAIR CONDUCTORS, 20AWG, SHIELDED, PVC JACKET
⑨ ALPHA FIT-321 ¼" DIA x 25mm
SOLDER DRAIN WIRE TO CONNECTOR BODY ON THIS END ONLY
370
150
200

DB9 FEMALE
REAR VIEW




DB25 MALE
REAR VIEW




| SIGNAL | WIRE COLOUR | DB9 PIN | DB25 PIN |
|---|---|---|---|
| PS ON/OFF COMMON | BLACK | 9 | 24 |
| PS ON/OFF CONTACT | RED | 8 | 5 |
| CURRENT MONITOR | WHITE | 3 | 7 |
| CURRENT MONITOR RTN | BLACK | 4 | 6 |
| VOLTAGE MONITOR | BLUE | 6 | 19 |
| VOLTAGE MONITOR RTN | BLACK | 7 | 6 |
| CURRENT PROG. 10V | YELLOW | 1 | 16 |
| CURRENT PROG. RTN | BLACK | 2 | 23 |
| COMMON | GREEN | 5 | 24 |

CUT LENGTHS:
- CURRENT CABLE – 1230mm
- GROUND – 1350mm
- INTERLOCK – 1320mm

⚠ WARNING: THE RED (POSITIVE) TERMINATION OF THE CABLE MUST BE CONNECTED TO THE POSITIVE TERMINALS OF THE DC POWER SUPPLY AND THE 5971-160 REVERSAL SWITCH. INCORRECT CONNECTION WILL DAMAGE THE REVERSAL SWITCH, VOIDING THE WARRANTY.

NOTE:
1. REFER TO DRAWING 169XX-0000-0 FOR BASIC CABLE ASSEMBLY
2. MAXIMUM CONTINUOUS CURRENT: 160 Amps
3. TOTAL CABLE RESISTANCE: 0.0008 Ohms
4. NOMINAL VOLTAGE DROP @ MAXIMUM CURRENT: 0.14 Volts

| ITEM | QTY | PART NUMBER | DESCRIPTION | NOTE |
|---|---|---|---|---|
| 18 | 1 | C88E321005 | S-SUB 25 PIN CONNECTOR HOOD | |
| 17 | 1 | 5-747912-2 | D-SUB 25 PIN CONNECTOR, MALE, SOLDER CUP | |
| 16 | 1 | C88E301005 | S-SUB 9 PIN CONNECTOR HOOD | |
| 15 | 1 | 5-747905-2 | D-SUB 9 PIN CONNECTOR, FEMALE, SOLDER CUP | |
| 14 | 1 | 10907-0059-1 | LABEL, REVERSAL SWITCH END | |
| 13 | 1 | 10907-0059-0 | LABEL, DC POWER SUPPLY END | |
| 12 | 2 | FIT-221-1-RED | SHRINK TUBING, RED, 1" X 60mm | |
| 11 | 4 | FIT-321-1 | SHRINK TUBING, ADHESIVE WALL, 1" X 70mm | |
| 10 | 2 | FIT-321-1/2 | SHRINK TUBING, ADHESIVE WALL, ½" X 25mm | |
| 9 | 2 | FIT-321-1/4 | SHRINK TUBING, ADHESIVE WALL, ¼" X 25mm | |
| 8 | 2 | FIT-221-1.5-CLEAR | SHRINK TUBING, CLEAR, 1.5" X 100mm | |
| 7 | 2 | FIT-321-1.5 | SHRINK TUBING, ADHESIVE WALL, 1.5" X 90mm | |
| 6 | A/R | XPF1-1/4 | EXPANDABLE POLYESTER SLEEVING, FLAME RETARDANT | |
| 5 | 2 | CTL4-38 | COPPER COMPRESSION LUG, #4 CABLE, ⅜" STUD | |
| 4 | 4 | LCB 2/0-38 | COPPER COMPRESSION LUG, 2/0 CABLE, ⅜" STUD | |
| 3 | A/R | 5475C | CABLE, 5 PAIR, SHIELDED, 20AWG, PVC JACKET | |
| 2 | A/R | A2004B | GROUND WIRE, #4, COBRA X-FLEX, BLACK | |
| 1 | A/R | A2002B-07 | CABLE, COBRA X-FLEX, 2/0, BLACK INSULATION | |

PARTS LIST

| | | |
|---|---|---|
| DRAWN M. Duffy | DATE 9 Dec, 2010 | DO NOT SCALE FROM DRAWING |
| CHECK M. Duffy | DATE 9 Dec, 2010 | DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED) |
| ENGINEERING M. Duffy | DATE 9 Dec, 2010 | |
| NEXT ASSY | SYSTEM | |
| SOFTWARE AUTOCAD 2000 | | |

| LINEAR | INCHES | mm |
|---|---|---|
| X.XXX | ±.005 | ±0.03 |
| X.XX | ±.01 | ±0.1 |
| X.X | ±.03 | ±0.3 |
| X | ±.06 | ±1 |
| DEG. | ±.5 | ±0.5 |
| FINISH | 63 ✓ | 1.6 ✓ |

THIRD ANGLE PROJECTION

GMW
955 Industrial Rd, San Carlos, CA 94070
Tel: (650)802-8292. Fax: (650)802-8298.

TITLE
5971-160 MOSFET Reversal Switch to SGA100-150

| SIZE | DRAWING NO. | REV |
|---|---|---|
| A1 | 16907-0062-2 | A |

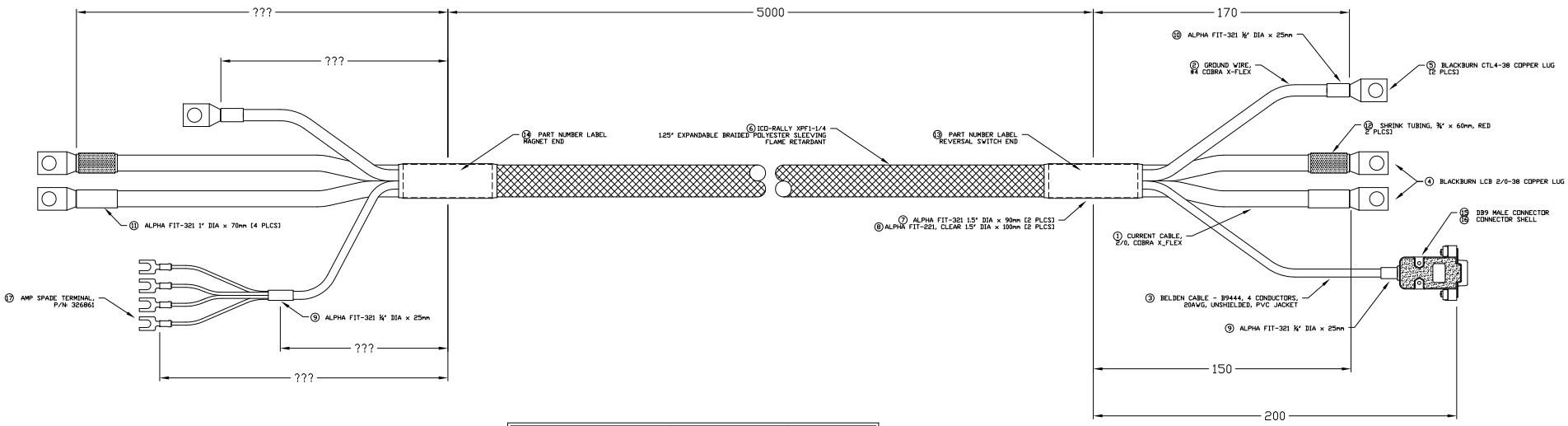
| SCALE | WT kg | SHEET 1 OF 1 |
|---|---|---|

PROPRIETARY
THIS DRAWING CONTAINS CONFIDENTIAL INFORMATION PROPRIETARY TO GMW INC. IT MUST NOT BE REPRODUCED OR DISCLOSED TO OTHERS OR USED IN ANY OTHER WAY, IN WHOLE OR IN PART EXCEPT AS AUTHORIZED IN WRITING BY GMW INC.

| REVISIONS | | | | |
|---|---|---|---|---|
| REV | DESCRIPTION | DRAFT | DATE | APPROVED |
| A | RELEASE | | 9 Dec, 2010 | M. Duffy |

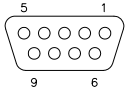
"A" END
CONNECT TO ELECTROMAGNET

"B" END
CONNECT TO 5971-160
REVERSAL SWITCH


???
???
5000
170
⑭ PART NUMBER LABEL MAGNET END
⑥ ICD-RALLY XPF1-1/4 1.25" EXPANDABLE BRAIDED POLYESTER SLEEVING FLAME RETARDANT
⑬ PART NUMBER LABEL REVERSAL SWITCH END
⑪ ALPHA FIT-321 1" DIA x 70mm (4 PLCS)
⑰ AMP SPADE TERMINAL, P/N 326861
⑨ ALPHA FIT-321 ¼" DIA x 25mm
⑦ ALPHA FIT-321 1.5" DIA x 90mm (2 PLCS)
⑧ ALPHA FIT-221, CLEAR 1.5" DIA x 100mm (2 PLCS)
⑩ ALPHA FIT-321 ½" DIA x 25mm
② GROUND WIRE, #4 COBRA X-FLEX
⑤ BLACKBURN CTL4-38 COPPER LUG (2 PLCS)
⑫ SHRINK TUBING, ¾" x 60mm, RED (2 PLCS)
④ BLACKBURN LCB 2/0-38 COPPER LUG
⑮ DB9 MALE CONNECTOR
⑯ CONNECTOR SHELL
① CURRENT CABLE, 2/0, COBRA X_FLEX
③ BELDEN CABLE - 89444, 4 CONDUCTORS, 20AWG, UNSHIELDED, PVC JACKET
⑨ ALPHA FIT-321 ¼" DIA x 25mm
150
200

| SIGNAL | WIRE COLOUR | DB9 PIN |
|---|---|---|
| TEMP. INTLK. OUT | BLACK | 1 |
| TEMP. INTLK. RETN | RED | 9 |
| FLOW INTLK. OUT | GREEN | 5 |
| FLOW INTLK. RETN | WHITE | 6 |

DB9 MALE
REAR VIEW




REFER TO DRAWINGS 13907-0009-0 & 13907-0009-1 FOR INTERLOCK TERMINATIONS ON THE ELECTROMAGNET.

CUT LENGTHS:
- CURRENT CABLE – 5580mm
- GROUND – 5360mm
- INTERLOCK – 5500mm

NOTE:
1. REFER TO DRAWING 169XX-0000-0 FOR BASIC CABLE ASSEMBLY
2. MAXIMUM CONTINUOUS CURRENT: 160 Amps
3. TOTAL CABLE RESISTANCE: 0.0036 Ohms
4. NOMINAL VOLTAGE DROP @ MAXIMUM CURRENT: 0.58 Volts

| ITEM | QTY | PART NUMBER | DESCRIPTION | NOTE |
|---|---|---|---|---|
| 17 | 4 | 326861 | AMP PIDG FORK TERMINAL, #6, 22 – 16AWG | |
| 16 | 1 | C88E301005 | S-SUB 9 PIN CONNECTOR HOOD | |
| 15 | 1 | 5-747905-2 | D-SUB 9 PIN CONNECTOR, MALE, SOLDER CUP | |
| 14 | 1 | 10907-0059-1 | LABEL, MAGNET END | |
| 13 | 1 | 10907-0059-0 | LABEL, REVERSAL SWITCH END | |
| 12 | 2 | FIT-221-1-RED | SHRINK TUBING, RED, 1" X 60mm | |
| 11 | 4 | FIT-321-1 | SHRINK TUBING, ADHESIVE WALL, 1" X 70mm | |
| 10 | 2 | FIT-321-1/2 | SHRINK TUBING, ADHESIVE WALL, ½" X 25mm | |
| 9 | 2 | FIT-321-1/4 | SHRINK TUBING, ADHESIVE WALL, ¼" X 25mm | |
| 8 | 2 | FIT-221-1.5-CLEAR | SHRINK TUBING, CLEAR, 1.5" X 100mm | |
| 7 | 2 | FIT-321-1.5 | SHRINK TUBING, ADHESIVE WALL, 1.5" X 90mm | |
| 6 | A/R | XPF1-1/4 | EXPANDABLE POLYESTER SLEEVING, FLAME RETARDANT | |
| 5 | 2 | CTL4-38 | COPPER COMPRESSION LUG, #4 CABLE, ⅜" STUD | |
| 4 | 4 | LCB 2/0-38 | COPPER COMPRESSION LUG, 2/0 CABLE, ⅜" STUD | |
| 3 | A/R | 5475C | CABLE, 5 PAIR, SHIELDED, 20AWG, PVC JACKET | |
| 2 | A/R | A2004B | GROUND WIRE, #4, COBRA X-FLEX, BLACK | |
| 1 | A/R | A2002B-07 | CABLE, COBRA X-FLEX, 2/0, BLACK INSULATION | |

PARTS LIST

| | | |
|---|---|---|
| DRAWN | M. Duffy | 9 Dec, 2010 |
| CHECK | M. Duffy | 9 Dec, 2010 |
| ENGINEERING | M. Duffy | 9 Dec, 2010 |
| NEXT ASSY | SYSTEM | |
| SOFTWARE | AUTOCAD 2000 | |

DO NOT SCALE FROM DRAWING
DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED)

| LINEAR | INCHES | mm |
|---|---|---|
| X.XXX | ±.005 | ±0.03 |
| X.XX | ±.01 | ±0.1 |
| X.X | ±.03 | ±0.3 |
| X | ±.06 | ±1 |
| DEG. | ±.5 | ±0.5 |
| FINISH | 63 | 1.6 |

THIRD ANGLE PROJECTION

GMW
955 Industrial Rd, San Carlos, CA 94070
Tel: (650)802-8292. Fax: (650)802-8298.

TITLE
5971-160 MOSFET Reversal Switch to 3474-140

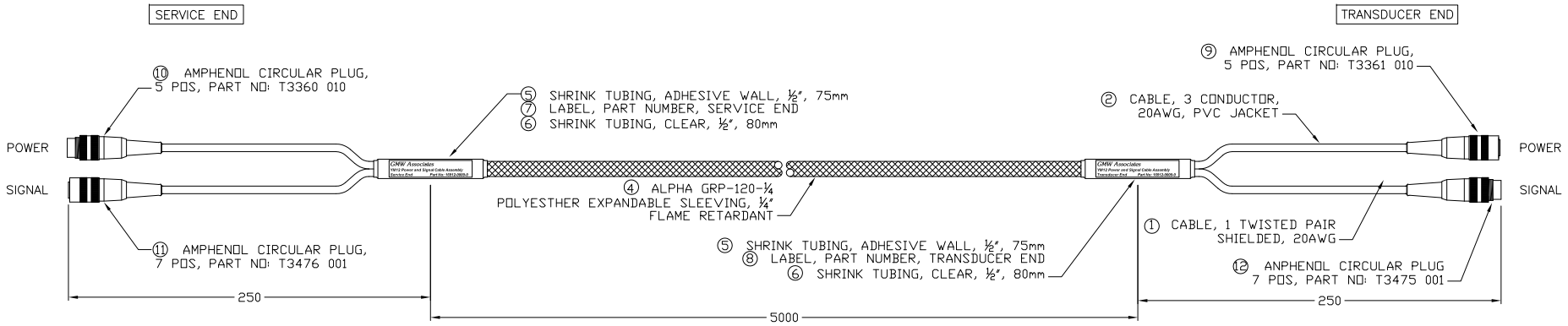
| SIZE | DRAWING NO. | REV |
|---|---|---|
| A1 | 16907-0053-3 | A |

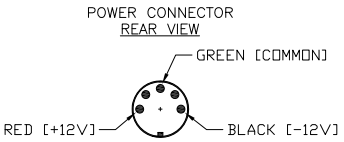
| SCALE | WT kg | SHEET 1 OF 1 |
|---|---|---|

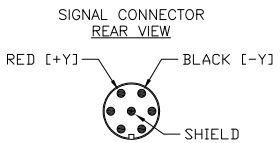
PROPRIETARY
THIS DRAWING CONTAINS CONFIDENTIAL INFORMATION PROPRIETARY TO GMW INC. IT MUST NOT BE REPRODUCED OR DISCLOSED TO OTHERS OR USED IN ANY OTHER WAY, IN WHOLE OR IN PART EXCEPT AS AUTHORIZED IN WRITING BY GMW INC.

REVISIONS

| REV | DESCRIPTION | DRAFT | DATE | APPROVED |
|---|---|---|---|---|
| A | RELEASE | | 5 Aug, 08 | M. Duffy |
| B | CORRECT POLARITY OF SIGNAL CONNECTOR | | 16 Dec, 08 | M. Duffy |
| C | CHANGE SIGNAL CABLE SPECIFICATION | | 20 Feb, 09 | M. Duffy |


SERVICE END
TRANSDUCER END
⑩ AMPHENOL CIRCULAR PLUG, 5 POS, PART NO: T3360 010
⑤ SHRINK TUBING, ADHESIVE WALL, ½", 75mm
⑦ LABEL, PART NUMBER, SERVICE END
⑥ SHRINK TUBING, CLEAR, ½", 80mm
⑨ AMPHENOL CIRCULAR PLUG, 5 POS, PART NO: T3361 010
② CABLE, 3 CONDUCTOR, 20AWG, PVC JACKET
POWER
SIGNAL
④ ALPHA GRP-120-¼ POLYESTHER EXPANDABLE SLEEVING, ¼" FLAME RETARDANT
⑤ SHRINK TUBING, ADHESIVE WALL, ½", 75mm
⑧ LABEL, PART NUMBER, TRANSDUCER END
⑥ SHRINK TUBING, CLEAR, ½", 80mm
① CABLE, 1 TWISTED PAIR SHIELDED, 20AWG
⑪ AMPHENOL CIRCULAR PLUG, 7 POS, PART NO: T3476 001
⑫ ANPHENOL CIRCULAR PLUG 7 POS, PART NO: T3475 001
250
5000
250




SERVICE END LABEL 2:1

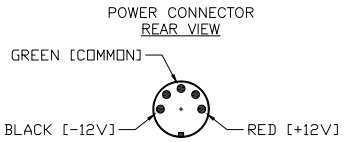
*GMW Associates*
***YM12 Power and Signal Cable Assembly***
***Service End Part No: 16912-0000-0***

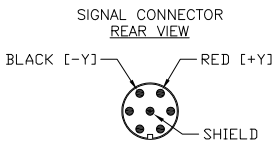
TRANSDUCER END LABEL 2:1

*GMW Associates*
***YM12 Power and Signal Cable Assembly***
***Transducer End Part No: 16912-0000-0***

12

60




NOTE:
1: REFER TO DRAWING NO: 169XX-0000-0; "BASIC ASSEMBLY OF CABLES FITTED WITH EXPANDABLE NYLON SLEEVING" FOR CABLE ASSEMBLY PROCEDURES.

2: POWER CABLE TYPE IS BELDEN 9444 – 4 CONDUCTORS; RED, BLACK, GREEN & WHITE. THE WHITE WIRE IS NOT USED AND SHOULD BECUT BACK UNDER THE SHEATH AT BOTH ENDS.

| ITEM | QTY | PART NUMBER | DESCRIPTION | NOTE |
|---|---|---|---|---|
| 12 | 1 | T3475 001 | AMPHENOL CIRCULAR CONNECTOR, 7 POS, MALE | |
| 11 | 1 | T3476 001 | AMPHENOL CIRCULAR CONNECTOR, 7 POS, FEMALE | |
| 10 | 1 | T3360 010 | AMPHENOL CIRCULAR CONNECTOR, 5 POS, MALE | |
| 9 | 1 | T3361 010 | AMPHENOL CIRCULAR CONNECTOR, 5 POS, FEMALE | |
| 8 | 1 | | LABEL, PART NUMBER, TRANSDUCER END | |
| 7 | 1 | | LABEL, PART NUMBER, SERVICE END | |
| 6 | 2 | FIT-221-1/2-CLEAR | SHRINK TUBING, CLEAR, 1/2" x 80mm | |
| 5 | 2 | FIT-321-1/2 | SHRINK TUBING, ADHESIVE WALL, 1/2" x 75mm | |
| 4 | A/R | GRP-120-1/4 | POLYESTER EXPANDABLE SLEEVING, 1/4" | |
| 3 | A/R | | ELECTRICAL TAPE, 1/2" x 50mm, BLACK | |
| 2 | A/R | B9444 | CABLE, 4 CONDUCTOR, 20AWG | |
| 1 | A/R | 318-059-2002-B | CABLE, 1 TWISTED PAIR, SHIELDED, 20AWG | |

PARTS LIST

| | | |
|---|---|---|
| DRAWN M. Duffy | DATE 5 Aug, 08 | DO NOT SCALE FROM DRAWING |
| CHECK M. Duffy | DATE 5 Aug, 08 | DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED) |
| ENGINEERING M. Duffy | DATE 5 Aug, 08 | |
| NEXT ASSY | SYSTEM | |
| SOFTWARE AUTOCAD 2000 | | |

| LINEAR | INCHES | mm |
|---|---|---|
| X.XXX | ±.005 | ±0.03 |
| X.XX | ±.01 | ±0.1 |
| X.X | ±.03 | ±0.3 |
| X | ±.06 | ±1 |
| DEG. | ±.5 | ±0.5 |
| FINISH | 63 ✓ | 1.6✓ |

THIRD ANGLE PROJECTION

GMW
955 Industrial Rd, San Carlos, CA 94070
Tel: (650)802-8292. Fax: (650)802-8298.

TITLE
SENIS YM12 CABLE SIGNAL AND POWER

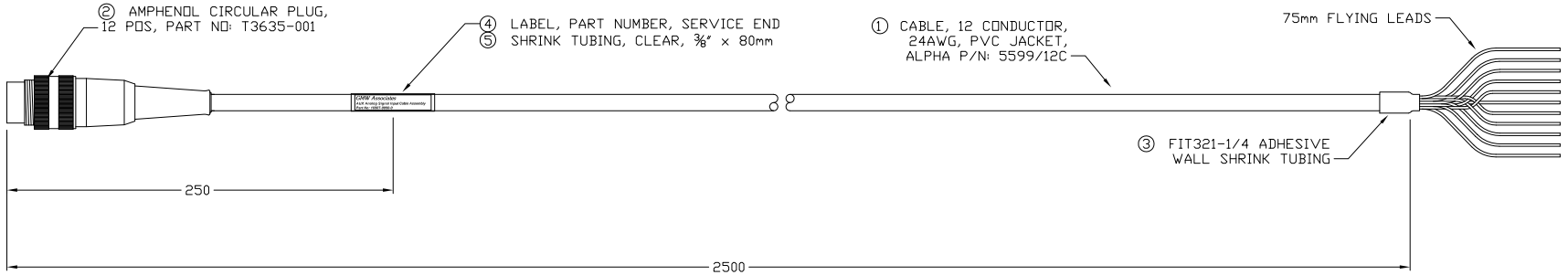
| SIZE | DRAWING NO. | REV |
|---|---|---|
| A1 | 16912-0000-0 | C |

| SCALE | WT kg | SHEET 1 OF 1 |
|---|---|---|

PROPRIETARY
THIS DRAWING CONTAINS CONFIDENTIAL INFORMATION PROPRIETARY TO GMW INC. IT MUST NOT BE REPRODUCED OR DISCLOSED TO OTHERS OR USED IN ANY OTHER WAY, IN WHOLE OR IN PART EXCEPT AS AUTHORIZED IN WRITING BY GMW INC.

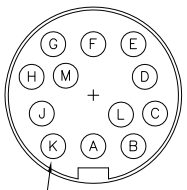
REVISIONS

| REV | DESCRIPTION | DRAFT | DATE | APPROVED |
|---|---|---|---|---|
| A | RELEASE | | 27 Feb, 12 | M. Duffy |
| B | CHANGE ITEM 1, CABLE AND TERMINATION CHART | | 25 Jul, 12 | M. Duffy |


② AMPHENOL CIRCULAR PLUG, 12 POS, PART NO: T3635-001
④ LABEL, PART NUMBER, SERVICE END
⑤ SHRINK TUBING, CLEAR, ⅜" x 80mm
① CABLE, 12 CONDUCTOR, 24AWG, PVC JACKET, ALPHA P/N: 5599/12C
75mm FLYING LEADS
③ FIT321-1/4 ADHESIVE WALL SHRINK TUBING
250
2500

POWER CONNECTOR
REAR VIEW

SIGNAL CONNECTOR
REAR VIEW
(TERMINATION)




SHIELD – CONNECT THE DRAIN WIRE TO THIS PIN. DO NOT CONNECT THE DRAIN WIRE TO THE CONNECTOR SHELL

| SIGNAL | WIRE COLOUR | CONNECTOR PIN | DAQ TERMINAL |
|---|---|---|---|
| CHANNEL A + | BLACK | A | AI–3 |
| CHANNEL A – | BROWN | B | AI–11 |
| CHANNEL B + | RED | C | AI–4 |
| CHANNEL B – | ORANGE | D | AI–12 |
| CHANNEL C + | YELLOW | E | AI–5 |
| CHANNEL C – | GREEN | F | AI–13 |
| CHANNEL D + | BLUE | G | AI–6 |
| CHANNEL D – | VIOLET | H | AI–14 |
| CHANNEL E + | GREY | L | AI–7 |
| CHANNEL E – | WHITE | M | AI–15 |
| ANALOG GND | WHT/BLK | J | AI–GND |
| SHIELD | DRAIN | K | CASE GROUND |

SERVICE END LABEL 2:1

***GMW Associates***
***AUX Analog Signal Input Cable Assembly***
***Part No: 16907-0090-0***

| ITEM | QTY | PART NUMBER | DESCRIPTION | NOTE |
|---|---|---|---|---|
| 5 | 2 | FIT221–3/8 | SHRINK TUBING CLEAR, 3/8" x 80mm | |
| 4 | 1 | – | PART NUMBER LABEL | |
| 3 | 1 | FIT321–1/4 | SHRINK TUBING, ADHESIVE WALL, 1/4" x 20mm LONG | |
| 2 | 1 | T3635–001 | CIRCULAR CONNECTOR, 12 POLE | |
| 1 | A/R | 5599/12C | CABLE, 12 CONDUCTOR, SHIELDED, 24AWG | |

PARTS LIST

| | | |
|---|---|---|
| DRAWN | M. Duffy | DATE 27 Feb, 12 |
| CHECK | M. Duffy | DATE 27 Feb, 12 |
| ENGINEERING | M. Duffy | DATE 27 Feb, 12 |
| NEXT ASSY | SYSTEM | |
| SOFTWARE | AUTOCAD 2000 | |

DO NOT SCALE FROM DRAWING
DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED)

| LINEAR | INCHES | mm |
|---|---|---|
| X.XXX | ±.005 | ±0.03 |
| X.XX | ±.01 | ±0.1 |
| X.X | ±.03 | ±0.3 |
| X | ±.06 | ±1 |
| DEG. | ±.5 | ±0.5 |
| FINISH | 63 ✓ | 1.6✓ |

THIRD ANGLE PROJECTION

GMW
955 Industrial Rd, San Carlos, CA 94070
Tel: (650)802–8292. Fax: (650)802–8298.

TITLE
231HC BIPOLAR AMPLIFIER
ANALOG INPUT CABLE

| SIZE | DRAWING NO. | REV |
|---|---|---|
| A1 | 16907–0090–0 | A |

SCALE | WT kg | SHEET 1 OF 1

## Section 8

## PHOTOGRAPHS

5971-160 Front View

5971-160 Rear View

## Section 9

## 5971-160 with GMW ELECTROMAGNETS

### 9.1 Table - GMW Electromagnets and appropriate DC Power Supplies for use with the 5971-160 Current Reversal Switch

| GMW Electromagnet | Peak DC Power | Ametek - Sorenson Power Supply |
|---|---|---|
| 5403, 5403EG, 5403FC, 5403AC | 70A, 33V, 2.3kW | DLM40-75E, 40V, 75A, 3kW |
| 5404 | 70A, 160V, 11.2kW | SGA 200/75, 200V, 75A, 15kW |
| 3472-50, 3472-70 | 70A, 50V, 3.5kW | SGA 60/83, 60V, 83A, 5kW |
| 3473-50, 3473-70 | 70A, 59V, 4.1kW | SGA 60/83, 60V, 83A, 5kW |
| 3474, 5501 | 140A, 76V, 10.6kW | SGA100/150, 100V, 150A, 15kW |
| 5414 | 140A, 116V, 16.2kW | SGA160/150, 160V, 150A, 25kW |
| 5451 | 70A, 25V, 1.75kW | DLM40-75E, 40V, 75A, 3kW |

### 9.2 Performance Data

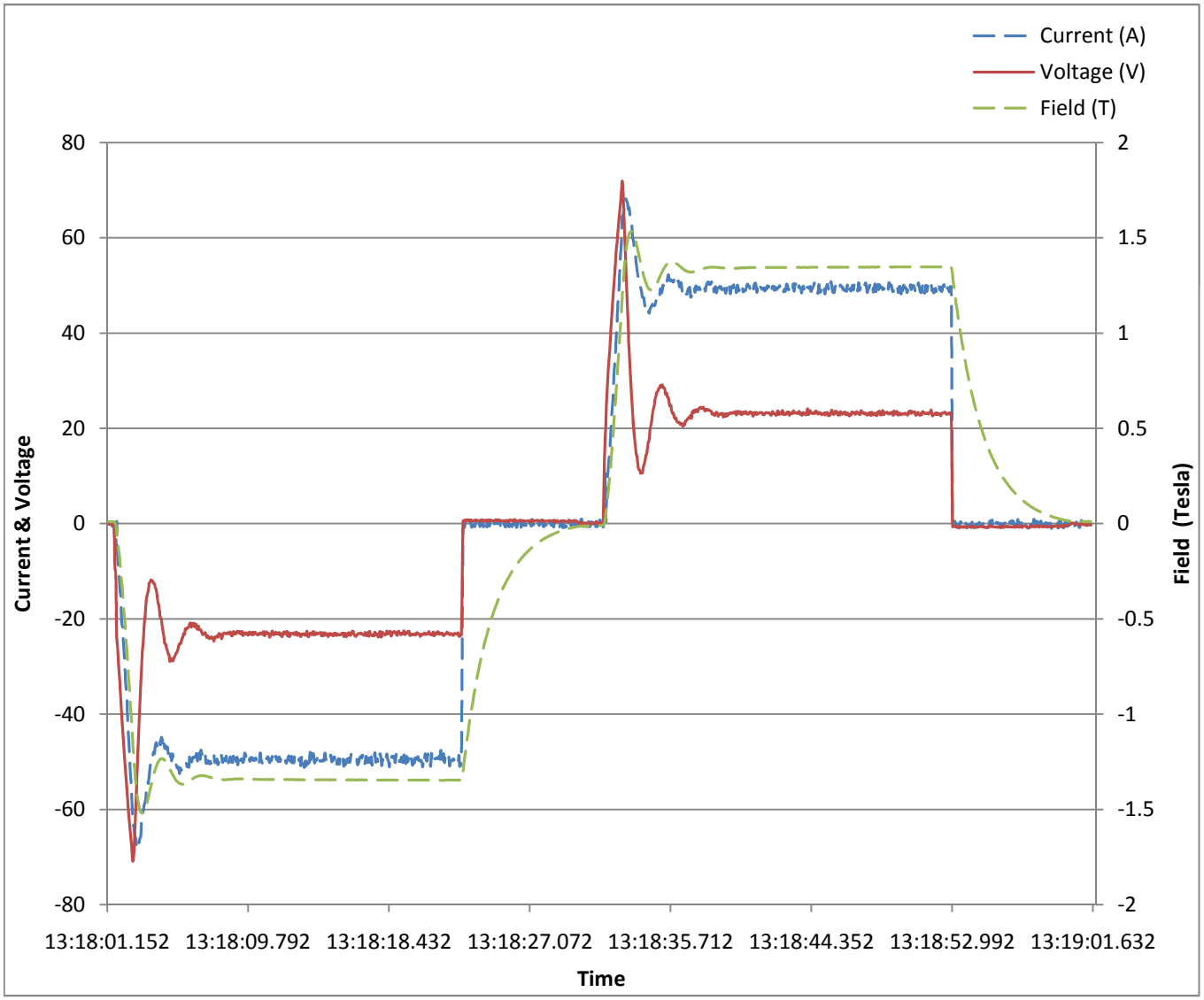
# GMW Associates

5971-160 Reversing Switch Performance Plot

| | | | | | |
|---|---|---|---|---|---|
| Contract No: | 9625 | Page: | 1 of 1 | Date: | 2 Dec, 2010 |
| Customer: | Army Research Lab | | | Engr: | M. Duffy |

| | | | |
|---|---|---|---|
| 5971-160 Serial No: | 02 | | |
| Power Supply: | P83C-100150 | Serial No: | 0250A00730 |
| Magnet Model: | 3474 | Serial No: | 105 |
| Pole: | 50mm | Gap: | 30mm |
| Field Meter: | Senis YM12-5-5-5T | Serial No: | 24-07 |

Note: Set Current: 50A, Timed Switching every 30 seconds.



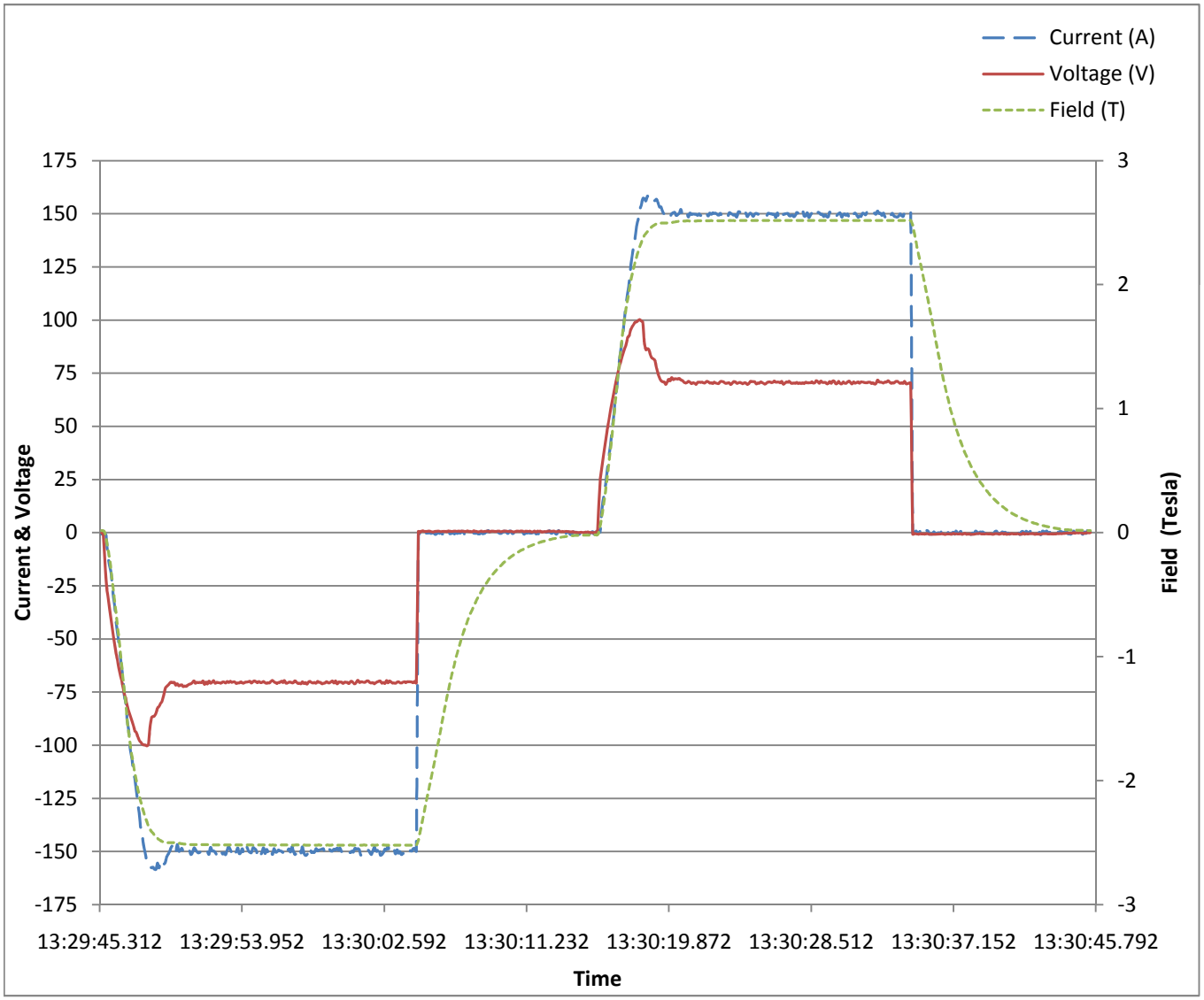
# GMW Associates

5971-160 Reversing Switch Performance Plot

| | | | | | |
|---|---|---|---|---|---|
| Contract No: | 9625 | Page: | 1 of 1 | Date: | 2 Dec, 2010 |
| Customer: | Army Research Lab | | | Engr: | M. Duffy |

| | | | |
|---|---|---|---|
| 5971-160 Serial No: | 02 | | |
| Power Supply: | P83C-100150 | Serial No: | 0250A00730 |
| Magnet Model: | 3474 | Serial No: | 105 |
| Pole: | 50mm | Gap: | 30mm |
| Field Meter: | Senis YM12-5-5-5T | Serial No: | 24-07 |

Note: Set Current: 150A, Timed Switching every 30 seconds.



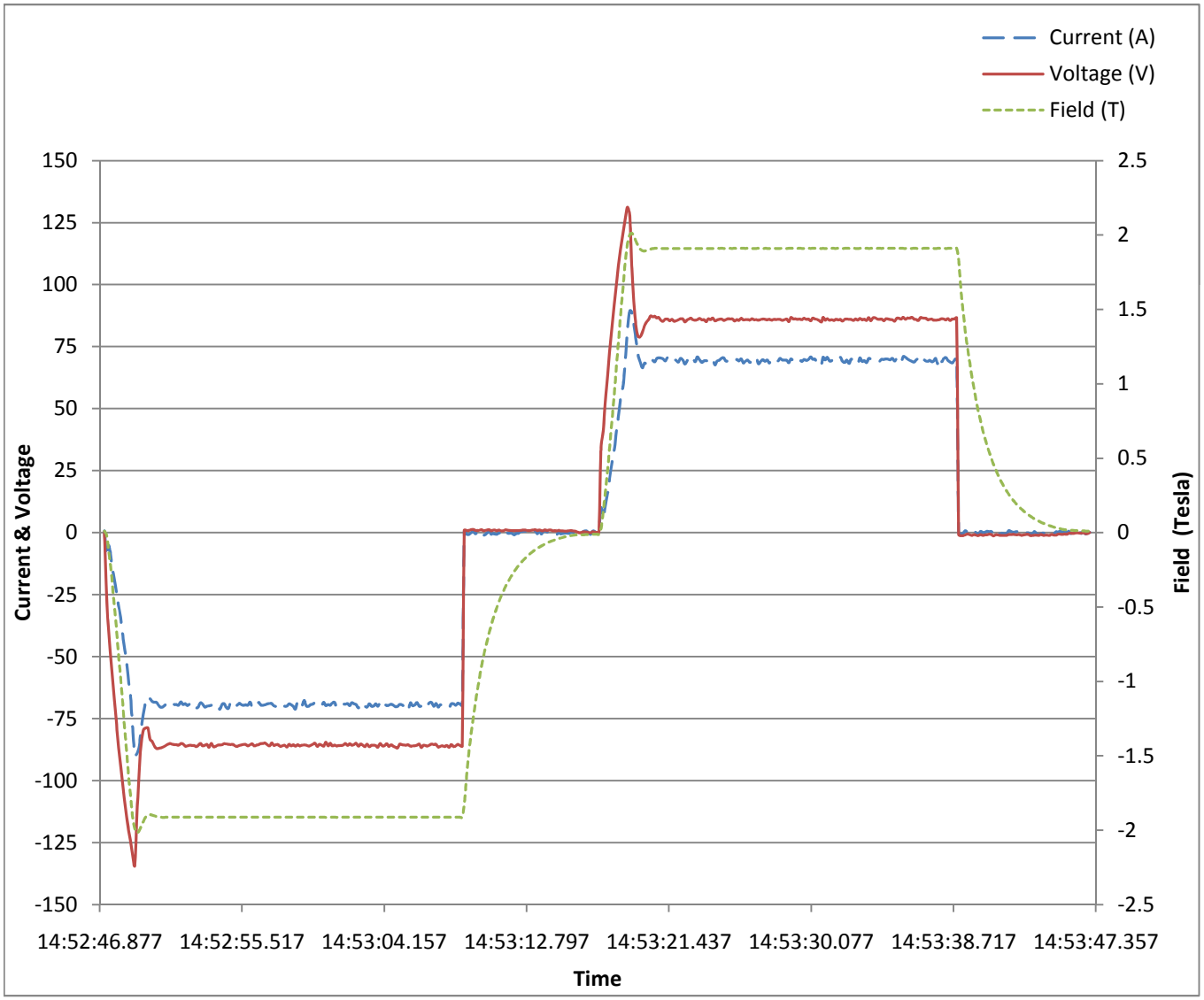
# GMW Associates

5971-160 Reversing Switch Performance Plot

| | | | | | |
|---|---|---|---|---|---|
| Contract No: | 9625 | Page: | 1 of 1 | Date: | 7 Dec, 2010 |
| Customer: | Army Research Lab | | | Engr: | M. Duffy |

| | | | |
|---|---|---|---|
| 5971-160 Serial No: | 02 | | |
| Power Supply: | P83C-100150 | Serial No: | 0250A00730 |
| Magnet Model: | 3473 | Serial No: | 153 |
| Pole: | 100mm | Gap: | 25mm |
| Field Meter: | Senis YM12-5-5-5T | Serial No: | 24-07 |

Note: Set Current: 70A, Timed Switching every 30 seconds.



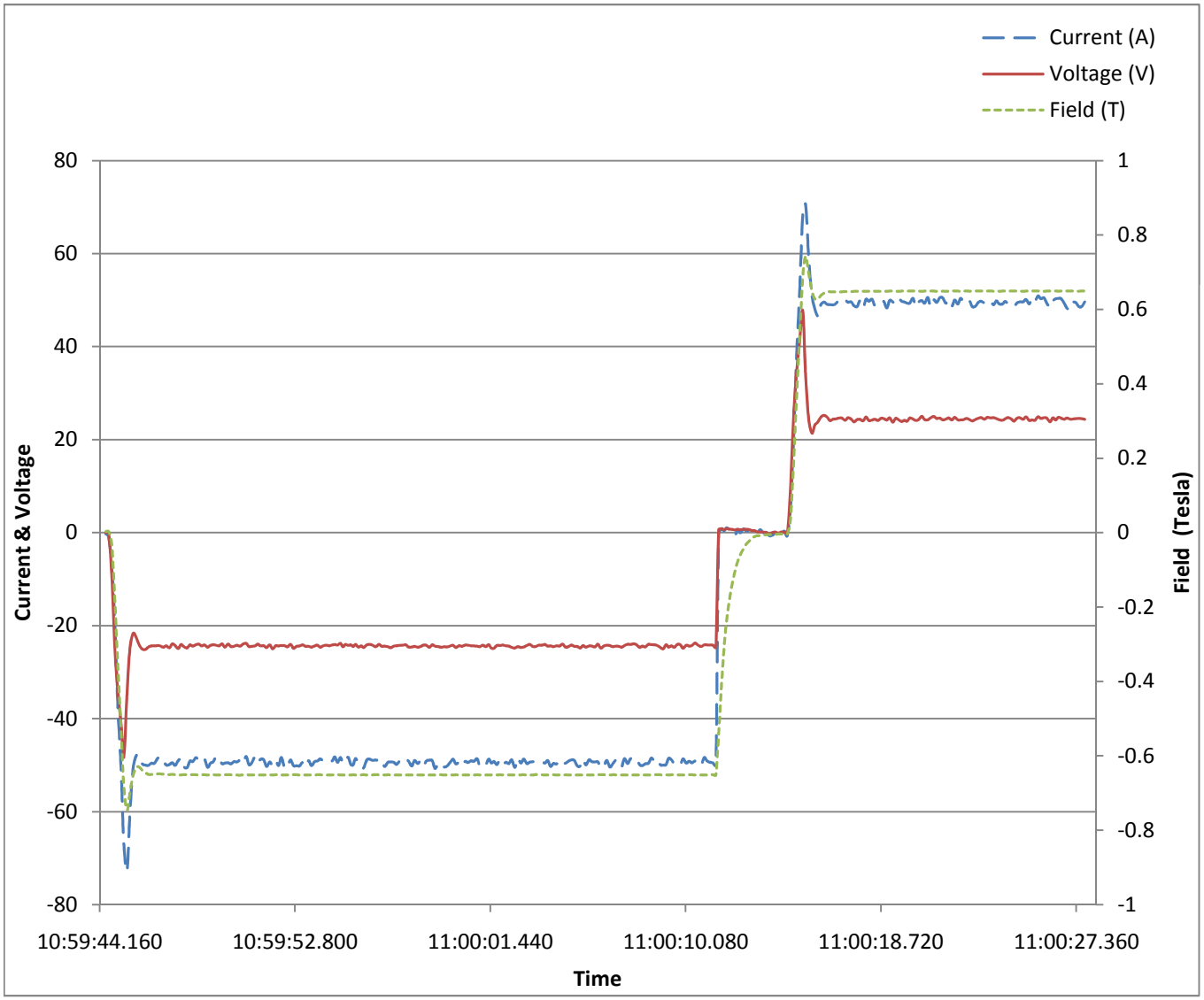
# GMW Associates

5971-160 Reversing Switch Performance Plot

| | | | | | |
|---|---|---|---|---|---|
| Contract No: | 9625 | Page: | 1 of 1 | Date: | 7 Dec, 2010 |
| Customer: | Army Research Lab | | | Engr: | M. Duffy |

| | | | |
|---|---|---|---|
| 5971-160 Serial No: | 02 | | |
| Power Supply: | P83C-100150 | Serial No: | 0250A00730 |
| Magnet Model: | 5403 | Serial No: | 352 |
| Pole: | 76mm | Gap: | 54mm |
| Field Meter: | Senis YM12-5-5-5T | Serial No: | 24-07 |

Note: Set Current: 50A, Timed Switching every 30 seconds.



GMW

# LABORATORY ELECTROMAGNET SYSTEMS
# WARRANTY DECEMBER 2010

GMW Associates warrants that all Electromagnets, Laboratory Electromagnet Systems and Electromagnet System Components supplied by GMW Associates will be free of defects in materials or workmanship for a period of 12 months from the date of installation or 15 months from the date of shipment whichever is the shorter.

Within this period GMW Associates will repair or replace defective parts free of charge either at the end user's site or at GMW Associates location at GMW choice.

GMW Associates will reimburse or pay the lowest two way freight charges on items returned to GMW Associates or our authorized agent provided prior authorization for shipment has been given by GMW Associates.

This warranty shall not apply to any equipment which our inspection shows to have become defective due to mishandling, misuse, improper maintenance or any other damage not generally acceptable for equipment of a similar type.

GMW Associates reserves the right to make changes in product or system design without incurring any obligation to modify previously delivered equipment.

The foregoing is the full extent of the GMW Associates warranty. No other warranty is expressed or implied. In no event shall GMW Associates be liable for damage arising from late delivery or misuse of the equipment. GMW Associates makes no warranty of the fitness of the equipment for the intended end-use other than the equipment meets the written specifications presented to the purchaser by GMW Associates.

If any defect or fault in the equipment is discovered the end-user should notify GMW Associates of the problem including details of Model numbers and serial numbers. GMW Associates will either make arrangements for service by the end-user or GMW Associates, or give authorization for return shipment to GMW Associates.

All return shipments must be made according to GMW Associates instructions with adequate packaging and documentation identifying the shipment including the GMW Associates Return Material Authorization (RMA) number. GMW Associates will not accept responsibility for equipment damaged in return shipment and thus all shipments should be properly packed and adequately insured by the customer.



*955 Industrial Road, San Carlos, CA 94070 Tel (650) 802-8292 Fax (650) 802-8298 Email sales@gmw.com*